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AN ASSESSMENT OF FACTORS AFFECTING SMALL MINING AND CUSTOM MILLING AND SMELTING OPERATIONS IN THE WESTERN UNITED STATES

PRINTED AT THE REQUEST OF

HON. HARRISON H. SCHMITT, *Chairman*

SUBCOMMITTEE ON
SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

MAY 13, 1982

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LETTER OF SUBMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION.
MAY 3, 1982.

DEAR COLLEAGUE: The Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation is pleased to release this report on factors affecting small mining and custom milling and smelting operations in seven of the Western United States. Information in the report was originally requested of the U.S. Bureau of Mines by Senator Howard W. Cannon (D-Nev.).

The subject of the report is of particular concern to the Committee, on which three of the seven States are represented. Senator Barry Goldwater (R-Ariz.) and I, as well as Senator Cannon, each has a longstanding interest in the capacity and health of the mining industries in our States.

In New Mexico, for instance, minerals mining is our largest industry, and closings of custom milling facilities in the last 15 years has created significant hardships for small miners.

The report takes on added significance against the backdrop of the Committee's concerns about the assured supply of critical minerals, particularly under circumstances of nonmilitary economic intervention.

My Subcommittee has held hearings on this issue under Public Law 96–479, "The National Materials and Minerals Policy Research and Development Act of 1980," which I and Senator Cannon worked to see passed in the last Congress. One of the inescapable conclusions of the hearings is the importance to the Nation's security of healthy domestic mining, milling and processing capabilities.

The report which we are releasing here will shed additional light on the problems and plans of small mining operations, which collectively carry a significant proportion of the risks of exploration, discovery and recovery. Their continued well being is an essential ingredient of our national prosperity and security.

HARRISON H. SCHMITT,
Chairman, Subcommittee on Science, Technology, and Space.

LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
APRIL 23, 1982.

Senator HARRISON H. SCHMITT,
Chairman, Subcommittee on Science, Technology, and Space, Committee on Commerce, Science, and Transportation, U.S. Senate.

DEAR SENATOR SCHMITT: I am pleased to transmit a report by the U.S. Bureau of Mines, prepared at my request, on evaluating small mining and custom milling and smelting operations in the Western United States.

This report was requested because of my concern over the continued decrease of milling and smelting facilities in the United States and the particular impact this trend has had on small mining operations in the West. The Bureau of Mines' response will contribute to a better understanding of the problem and assist what I hope will be the beginning of a constructive dialogue regarding appropriate steps to address our future needs in this important area.

With best wishes, I am,
Sincerely,

HOWARD W. CANNON,
U.S. Senator.

U.S. Department of the Interior,
Bureau of Mines,
Washington, D.C., January 29, 1982.

Hon. Howard W. Cannon,
U.S. Senate,
Washington, D.C.

Dear Senator Cannon: In response to your request of October 15, 1981, it is my pleasure to transmit to you the enclosed report "An Assessment of Factors Affecting Small Mining and Custom Milling and Smelting Operations in the Western United" by the Staff, Bureau of Mines. We refer you to the opening section for the summary and discussion of the principal findings of the report.

Please note that in order to meet the 90 day time frame available for the study the report was not subjected to the normal rigorous analytical and editorial treatment given our regular publications. However, as a preliminary assessment, I am confident that it will be a useful contribution to the dialogue on the subject area.

Sincerely,

Robert C. Horton,
Director.

Enclosure.

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, D.C., October 15, 1981.

MR. ROBERT C. HORTON,
Director, Bureau of Mines,
Department of the Interior,
Washington, D.C.

DEAR BOB: As you are aware, there is concern among many in the minerals sector over the continued decrease of milling and smelting facilities in the United States. Because of this decline it is becoming more difficult for individual prospectors and miners to have their ores and concentrates milled or processed.

I am particularly concerned because of the potential impact that this trend is having in Nevada and other western states where mining is an important part of our economic structure.

As a specific case study of national significance, could you please prepare for me a preliminary analysis of the major factors relative to this issue that addresses the state-of-the-art of technology for processing ores of gold, silver, copper, lead, zinc, or other non-fuel commodities of major importance to the minerals economy of Nevada and other western states; that identifies areas in which technological improvements could make a significant contribution toward improving process economics, thereby encouraging private sector investment; and that discusses alternative technologies that may be of utility to the individual prospector or miner.

I would appreciate an assessment of the significance of mining to the State's overall economy, present milling and smelting capacities (whether toll, captive, or a combination of the two), future prospects of milling and smelting operations within individual states, an economic assessment of current operations where known, the impact of environmental rules and regulations upon the continued operation of these plants, and any other pertinent information or data you think would aid individual miners and small operations to survive and continue to contribute to the growth of the minerals industry in this region.

I want to thank you for agreeing to have this important evaluation done by the Bureau of Mines. Your staff has indicated it may be possible to have this analysis completed in three months, in time for the Congress to make recommendations for Fiscal Year 1983. Your cooperation and assistance with this important matter is greatly appreciated.

With best wishes, I am,

Sincerely,

HOWARD W. CANNON.

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SUMMARY AND FINDINGS

INTRODUCTION

This study was prepared in response to an October 15, 1981, request from Senator Howard W. Cannon of Nevada to the Director, Bureau of Mines, U.S. Department of the Interior. In his letter, the Senator indicated that there is a concern among many in the minerals sector over the continued decrease of milling and smelting facilities in the United States. Because of this decline, it is becoming more difficult for individual prospectors and miners to have their ores and concentrates milled or processed.

In addressing this problem, the report focuses on seven States—Arizona, California, Colorado, Idaho, Nevada, New Mexico, and Utah—and seven mineral commodities—antimony, copper, gold, lead, silver, tungsten, and zinc. The report presents a brief examination of the state-of-the-art of process technology available for smaller scale operations; looks at the economic impact of mining on these States; looks at trends in milling and smelting capacity; and examines the major economic, regulatory, and policy factors, both present and historic, that have influenced mining and mineral processing in this country. The short study timing (3 months) was controlled by the initiating request from Senator Howard Cannon; therefore some data are incomplete. Some general observations are listed below:

1. The major problems facing the small miner in 1982 are:
    - o Currently depressed metal demand and prices.
    - o Increased costs and delays caused by the need to comply with government regulations.
    - o Longer transportation distances and higher costs caused by custom smelter closings.
    - o Lack of public awareness concerning the contribution of the small miner.
    - o An inability to produce a constant and/or sufficient flow of ore to maintain custom mills.
    - o Withdrawal of some lands, or access to lands, deemed favorable for prospecting and development.
    - o Increased foreign competition.
    - o Lack of capital to adequately determine the economic viability of his proposed mine.
2. The sum total of basic economics of the smelting industry (ore grades, labor, energy, environmental and technology costs, health and safety costs, etc.) is one of steady decline.

Some additional observations and conclusions derived from the preliminary assessment of technological operating factors and economic and policy factors that have an impact upon the success of the small miner are summarized as follows.

TECHNICAL OPERATING FACTORS

A. Technologic Assessment

The development by the Bureau of Mines of heap leaching and carbon adsorption techniques and their application have led to the most significant advances in the processing of low-grade gold-silver ores and small deposits of higher grade ore. Three other important contributions to gold-silver processing, also by the Bureau, were the development of the chlorine- and electro-oxidation processes to permit cyanidation of carbonaceous gold ores and the carbon-in-pulp process for treating slimy ores. The Bureau of Mines is continuing research in the areas of in situ and agglomeration heap leaching to improve the recovery of gold and silver from low grade and low tonnage deposits.

In searching for cleaner hydrometallurgical processes for treating sulfide concentrates, the Bureau has developed a ferric chloride leaching/fused salt electrolysis process for recovering lead and a pressurized chloride-oxygen leach for treating complex sulfides. Other hydometallurgical processes suitable for treating copper, lead, and zinc concentrates are also described.

B. Trends in Milling and Smelting

An examination of Bureau of Mines Minerals Availability System and field office records was made as part of this preliminary assessment of milling trends during the period 1965 to 1979-81. The data, owing to their absence or proprietary nature, were insufficient to establish any quantitative trends. However, several observations and conclusions can be made from the study.

- The majority of mills are captive.
- Most mills using gravity or flotation concentration can handle most gold, silver, sulfide, and tungsten (scheelite) ores. However, they will only treat custom ore when they can work it into their milling schedules. The mills prefer relatively homogeneous feed material and may be reluctant to accept different ore types or ores from different mining districts.
- The availability of custom mill capacity varies from State to State, for example, Nevada with over 3,000 tons per day of capacity has a much greater mill capacity than ore available. New Mexico and California, on the other hand, have been more heavily affected by mill closings in the past 15 years, and State officials report that the small miner has a problem locating custom milling facilities.
- Owing to poor economic and commodity price conditions, the base metal sulfide (copper, lead, and zinc) mills have experienced the most closures.
- Most new mill openings have been gold and silver operations, following the post-1973 precious metals price boom.

- Some of the small custom mills operate on an intermittent basis, opening only when sufficient ore is on hand or when prices are high enough for the mill to turn a profit.

- The increased use of heap leaching and carbon absorption recovery technology has reduced the percentage of gold mines still requiring the services of a custom mill.

Between 1955 and 1980, there has been an effective overall loss of 2 copper, 4 lead and 13 zinc smelters. This does not include the expected closure of the Bunker Hill lead/zinc smelter. Industry officials cite the cost of complying with the Clean Air Act as the principal cause of the smelter closures and a resultant loss of their competitive edge over foreign producers. They also mention the burden of disposing of large tonnages of pollution control byproduct sulfuric acid, for which there are no readily accessible domestic markets. And the continuing requirement to meet Clean Air Act standards,as currently written, could lead to the closure of 5 more copper smelters. In conjunction with the Anaconda smelter that closed in September 1980, this would represent a loss of 36 percent of domestic copper smelting capacity.

A 1970 report to Congress from the Secretary of Health, Education and Welfare estimated that the cost for all nonferrous smelters to achieve 98.8 percent SO_2 control would be $67.6 million. However, these original compliance costs were grossly underestimated. Over the years 1970-80, the copper smelting industry alone spent over $1.1 billion on air pollution controls—over 16 times as much as the 1970 estimate. This $1.1 billion expenditure has led to an increase in average capture of SO_2 from a 1961 figure of 7 percent to a current average of 60 percent, still short of the 98.8 percent mandated by the Clean Air Act.

The impact of environmental requirements in the copper industry is even greater, when one looks at the expenditures required for "total environmental, health, and safety compliance." Over the period 1970-79, pollution control expenditures in the nonferrous metals industry averaged nearly 18 percent of total capital expenditures. Comparable figures for iron and steel are 14.6 percent, electric utilities 8.1 percent, and all business 5.5 percent. According to recent Department of Commerce studies, the combined regulatory compliance costs for the copper industry for air, water, and worker health and safety regulations will total $4.5 billion in 1974 dollars over the period 1974-87. Air pollution controls account for the majority of these expenditures — $2.7 billion, all for control of smelter SO_2 emissions.

C. The Economics of Custom Milling and Smelting

Based on an investigation of custom gold milling in Colorado, custom cyanidation milling costs range from $35 to $40 per ton of ore. One mill operator requires 500-ton lots, while another requires enough for about 1 week's mill operation to make it worthwhile to set up for a particular ore. Lead-zinc milling costs are reported lower in the $3-$16 range. The general lack of ore is the major disincentive to establishing a new custom mill, as entrepreneurs have found it necessary to meet 80 percent of mill capacity feed from captive mines.

Historically, gold mills have opened and closed as dictated by "boom or bust" periods. Today a mill owner must provide a service capable of economically recovering gold from generally much leaner ores than those handled by previous operations—the higher grade ores having been worked out when prices were only $20 to $35 an ounce.

The most practical suggestions for dealing with these problems involve the establishment of centralized ore or concentrate buying stations, or of miner cooperatives to pool ore resources to provide sufficient continuous feed for a custom mill or a central heap leaching operation.

A general world shortage of lead and zinc concentrates has led to a seller's market, which has weakened the custom smelter's economic position. In the case of the Bunker Hill smelter closure, a contributing factor was its being forced to drop the normal labor and energy cost escalator contract clauses in order to remain competitive.

Smelter charges vary from one smelter to another; for example, $98 per ton of lead concentrate at one compared with $140 per ton at another. These charges and payments to the concentrate seller are discussed in detail and include such factors as assaying impurities, payments for specific ore constituents, and deductions for dealing with certain impurities and for allowing for metal losses in the smelting process. Smelter schedules also include deductions for demurrage, for treatment charges including power, fuel, and labor allowance, for excessive moisture, for charges to cover pollution control expenses, etc. Payments are usually based on specified Metals Week or London Metal Exchange prices and are due from 1 to 3 months after concentrates are received. This lag time in payments is often a sore point with the small operator with cash flow problems.

D. Transportation

The loss of a substantial number of copper, lead, and zinc smelters in the West over the past 15 years has added significantly to the distances the small miner must ship his concentrates for treatment. Shipment distances to the replacement smelters have increased in some cases by 200 to 1000 miles. Although a thorough analysis of current transportation cost impacts on the small miner is not yet available, one case studied suggests the transportation of concentrates to the smelters comprised 15 percent of total costs. Transportation costs can vary based on distances, the freight rates, the value of the shipment, and the arrangements with the smelter. One Boulder, Colo. operator indicated he chose a smelter that paid for the byproduct zinc in his concentrates because this payment covered his transport costs. Transportation any distance may not be practical for certain low-grade ores which are suitable only to in-situ or heap leaching treatment.

A Bureau of Mines study on the impact of rail abandonment on the nonfuel minerals industry concluded among other things that rail abandonment in the Western States could significantly reduce the opportunity to develop new resources or reopen defunct mining operations in those areas. This is particularly true if the smaller miner wanted to take advantage of the economies of scale available in shipping larger volumes of concentrates longer distances to a smelter by rail as opposed to highway truck haulage. The operating and regulatory structure of the rail and highway transport industries in the United States and some of the factors influencing the transportation of minerals are reviewed in excerpts from a study performed under contract to the Bureau.

ECONOMIC AND POLICY FACTORS

A. Significance of Mining to State Economies

Using an INPUT-OUTPUT model of the mineral sector of the U.S. economy, estimates were made for the output, employment, and income effects of the mining industry in seven States for 1977, 1978, and 1979. Crude estimates were also made of gross State products in order to show the direct output value of the respective mineral industries as a percent of gross State Product. Highlights of the fundings are presented in the following table.

Effect of production of nonfuel minerals and processed materials of nonfuel minerals origins on State economies

	Value of direct output As a percent of gross State product	Output effect (millions of current dollars)		Employment effect (thousands of jobs)		Income effect (millions of current dollars)	
States	1979	1977	1979	1977	1979	1977	1979
Arizona	9.0	6,263	8,969	131.2	134.4	1,779	2,416
California	.6	14,445	17,674	412.4	447.2	5,082	6,508
Colorado	2.4	2,442	3,283	78.5	94.8	963	1,269
Idaho	10-11	619	918	16.3	21.0	194	252
Nevada	8.0	665	752	19.5	24.9	206	302
New Mexico	20.0	1,684	2,463	39.9	45.3	476	716
Utah	9.0	2,642	3,617	111.0	119.9	2,182	2,741

Note: Output data reflect total direct plus indirect effects. Employment and income data reflect direct plus indirect plus induced effects.

New Mexico and Idaho, and to a lesser extent Arizona, Utah, and Nevada, show the heaviest dependencies on the metal mining and processing industries. The data show a general increase in all output, employment, and income effects in all States between 1977 and 1979. The decline in employment and income effects of the mining sector in Arizona in 1978 reflects the depressed copper market conditions and resulting production cutbacks in that year. The Idaho Division of Financial Management has estimated the impact on the State of the closing of the Bunker Hill lead-zinc-silver complex, as many as 4,600 local jobs, $80 million in wages, and $9 million in tax receipts may be lost by the end of 1982.

B. Project Financing Problems

All mineral producers, large and small, face problems in project financing. These problems are amplified for small miners, who are not able to absorb their impact as larger firms may be able to do. Large firms with sufficient profits are able to take advantage of a number of tax code provisions to enhance their cash flow, smaller firms operating at the margin are unable to do this. Additionally, small miners often lack the technical and management skills or sufficiently defined ore reserves that would serve as collateral to allow them to attract investors to project financing of their mines. The financial conditions in small mining, inferred from available data, are dismal.

Taxation is an important public policy instrument that can affect the profitability of firms. Severance taxes, unique to natural resources, are levied on metal production in most Western States. However, the rates are generally low, and exemption for small producers may exist. The Economic Recovery Tax Act of 1981 has made a number of changes in the tax law that should benefit small mining and processing operations. Among these changes are the reduction in corporate tax rates, the depreciation deduction, the investment tax credit, individual tax rate reduction, capital gains rate reduction, and the increase in accumulated earnings credit.

High interest rates are another factor that may affect the productive activities of small miners in a negative way. However, until recently, it has generally been advantageous to borrow even at the high rates because inflation reduced the real cost of borrowing. It is not clear that high interest rates affect small miners more than other groups in the economy. It appears that a reduction of interest rates generally would be more helpful than focusing action on small miners specifically.

C. Impact of Government Policies on Mining

An historical review of U.S. mineral policies over the past 40 years was made to examine the extent to which Government policies have affected the small miner. Throughout this period no policy initiative taken in behalf of the small miner has matched the significance and impact of the Mining Law of 1872 and its amendments. This law set the framework of land patent and claim procedures that helped establish the raw material base of the greatest industrial society in the world. Most U.S. legislation affecting the minerals industry since 1940 has been made in response to short-term demands of unstable and/or wartime economies or to address special interest problem areas such as the protection of the environment. Unlike the thrust of many foreign government mineral policies, which are also reviewed, U.S. Government policies have not been directed at providing an orderly and efficient development of our mineral resources. Increased domestic supplies were usually promoted through tax incentives, loans, price guarantees, purchase agreements, exploration and development assistance, technology research, and infrastructure development. Development of new domestic sources of metals such as tungsten, cobalt, gold, and uranium was at least a short-term benefit of many of these policies. While some of the more effective of these policies such as the Defense Production Act of 1950, are still in place, they are funded or implemented only in times of apparent need rather than being used to promote a continuous and orderly development of strategic and critical domestic resources. Foreign mineral supply sources were promoted through investment incentives, export-import loans, foreign aid, and various materials purchase agreements.

An examination of national stockpile policy shows an erratic pattern of management. During the 1950's, 1960's, and 1970's the stockpile was widely used, intentionally or not, as an economic buffer. Sales were often motivated by the need to balance the Federal budget or to stablize prices rather than by a concern for the health of the mineral industry. In fact, stockpile sales for domestic and export use of tungsten in the 1960's and 1970's and of copper at prices substantially higher than controlled domestic prices were at the direct expense of our domestic industries.

During the 1960's and 1970's public land, environmental, and health and safety policies had the greatest, and chiefly negative, impact on the mining industry. Foreign mineral policies such as increasing raw material processing, nationalization of U.S. investments, Government supports for certain mineral industries, the formation of mineral associations and cartels, OPEC petroleum price escalation, and changing international monetary policy were also felt by the U.S. mineral industry in the 1970's more than ever before.

D. Commodity Market Trends—1961-1980

Since commodity market trends have a strong effect on the economic viability of milling and smelting operations in the West, a brief review of trends in the seven minerals under study is presented.

Antimony - In constant dollar terms, prices increased nearly threefold between 1961 and the mid-1970's and have been on a moderate downward trend since then. Releases of antimony from the U.S. Government Stockpile have moderated major peak demand price pressures. The high prices of 1970 led to substitution and lost markets which took several years to be recovered. Demand for antimony is forecast to grow at an annual rate of 2.1 percent during 1978-2000.

Copper - Stable prices for this highly cyclical commodity prevailed from 1960 to 1964, followed by a 10-year Vietnam-fueled period of short supply and high prices. A serious down cycle followed from 1974 to 1978. Mine closures and unemployment were particularly high during 1977-78. Demand and prices rebounded sharply from 1979 to mid-1980 but were too short lived for the industry to fully recover from the previous down cycle. A new period of depressed copper pricesin 1981 is currently leading to an increasing number of production cutback announcements as costs continue to exceed prices at most mines. Long-term demand for copper is projected to grow at a rate of only 2.5 percent per year in the United States, compared with 4 percent in the rest of the world.

Gold - Until 1968 domestic industrial demand was met in part by a drawdown on U.S. Treasury gold stocks. Subsequent to the Treasury terminating its purchases and sales of gold in 1968, the United States has increasingly relied on imports to meet commercial gold demand. Although jewlery still accounts for about 50 percent of gold consumption, industrial and electronic uses for gold accounted for 40 percent of demand in 1980, compared with 29 percent in 1969. Since the legalization of private gold ownership in 1975, 3 to 6 percent of gold has gone into investment-related forms. Primary domestic mine production of gold peaked at 1.75 million ounces in 1970 and has been in a steady decline since then, reaching 773,000 ounces in 1980.

Primary shortfall has been more than compensated for by public gold auctions held by the Treasury and by the International Monetary Fund. Price and marketing conditions affecting the development of new small gold mines depend to a large extent upon the uncertain course of world political and economic events, and the impact of these events is more upon the price of gold in its role as a store of value rather than in its role as an industrial commodity.

Lead - Based on 1978 constant dollars, the U.S. producer price for lead doubled between 1961 and the peak year of 1979, going from 24 cents to 48 cents per pound. The entry of the Soviet Union into the free lead market, partly as a result of the loss of Iranian lead concentrates, and lower general availability of lead concentrates as a coproduct of zinc mining, led to a monthly high price of 61 cents per pound in October 1979. The decline of prices since then is attributed to declining markets in leaded gasoline and in car batteries. Foreign competition and lower cost production by the Missouri mines reduce incentives for the high-cost western lead mines and for the development of the small mines needed to maintain production levels. With the loss of 20 percent of domestic lead production caused by the Bunker Hill closing, it would appear that there will be room for the return of small mines and mills on the domestic scene.

Silver - The price of silver held relatively constant $1 to 2 per ounce between 1961 and 1973. Prices then stayed in the $4 range until late 1977, when strong speculative interest in silver drove the price rapidly up. An alltime high of $48 per ounce was reached in January 1980. Since then prices have fallen off, and the current price of $8 per ounce is not likely to greatly moderate silver demand, which appears to be price inelastic, because many industrial products have high unit values compared with the value of the silver content. In August 1981 the disposal of 105 million ounces of stockpile silver was authorized during fiscal years 1982-84. This could serve as a continuing price depressant and a disincentive to the development of small silver mines. However, in December 1981, a Senate Amendment to the Defense Appropriations Act (P.L. 97-114) placed a freeze on the sale of silver by the General Services Administration (GSA) until July 1982. The amendment calls for a study of alternative forms of disposing the silver that will be less disruptive to the market.

Tungsten - Prices based on constant dollars for tungsten concentrate were variable in the $3 to $4 range per pound of contained WO_3 without wide fluctuations from 1964 through 1973. However, prices rose 250 percent from 1973 through 1977, then dropped about 28 percent from 1977 through 1980. Many fluctuations in tungsten prices over the past 35 years are attributed to buying or selling intervention by the Governments of China, the U.S.S.R., and the United States and not to normal supply-demand forces. With prices expected to remain stable in constant terms over the next 10 to 15 years, small mine development should be profitable from the market standpoint.

Zinc - In 1978 constant-dollar terms, zinc prices showed little change from 1961 through 1971, averaging around 25 cents per pound with a small demand-driven push to 30 cents in the mid-1960's. Lending support to prices were import quotas on concentrate and metal, which ended in 1965, and a Government subsidy program, which expired in 1969, that provided stabilization payments to small lead and zinc miners. Under Public Law 87-347, small miners received 55 percent of the difference between 14.5 cents per pound and the average list price for zinc. Price controls during 1971-73 were followed by a period of high world demand, which pushed London Metal Exchange prices to a high of 97 cents per pound in 1974. Since then, zinc demand has been on a declining trend caused by automotive production cuts and design changes and general depressed economic conditions. The closures of existing mines and the postponement of new mine development caused by the low prices of the late 1970's led to a worldwide shortage of zinc concentrates. Forecasts of zinc demand through 2000 are dependent on end use patterns that are not fully developed. Growth rate forecasts range from a probable rate of 1.8 percent to a high of 3.3 percent per year, and it is not clear how demand trends will affect new small mine development.

E. Impact of Environmental Regulations on the Small Miner

Environmental regulations are affecting the small miner in three ways: Directly in the conduct of his operations, indirectly by influencing the economics of treating his ores in the mill or smelter, and indirectly by artificially influencing the price of commodities and the availability of markets for materials produced in response to environmental restrictions. The complexities of dealing with the technical aspects make it much more difficult for the small operator to run the classical "one man" operation. He must hire a variety of specialists to prepare a suitable engineering feasibility study and/or environmental impact statement, creating time delays and adding to overhead. This section of the report and appendix B provide a general analysis of selected provisions of environmental and health and safety laws regulations directly or indirectly affecting mining and mineral processing activities in the United States.

F. Mineral Land Access and the Small Miner

The Federal Government owns about 760 million acres of land, one-third of the Nation's total land base. Approximately 90 percent of these lands are located in the 11 Western States and Alaska. This section, along with appendix C, outlines the basic procedures and identifies the main regulations a small miner has to consider in seeking to claim lands for mineral development.

An Assessment of Factors Affecting Small Mining and Custom Milling and Smelting Operations in the Western United States

II. Introduction

This study was prepared in response to an October 15, 1981, request from Senator Howard W. Cannon of Nevada to the Director, Bureau of Mines, U.S. Department of the Interior. In his letter the Senator indicated that "there is a concern among many in the minerals sector over the continued decrease of milling and smelting facilities in the United States. Because of this decline it is becoming more difficult for individual prospectors and miners to have their ores and concentrates milled or processed." The Bureau of Mines has had particular concern over the problems of the small miner for many years and has focused some of its process technology research and development at addressing their needs. Within the past 6 years the Bureau has contributed to two major publications that are specifically addressed to the needs of the small miner:

> . Earll, F.N. et al. Handbook For Small Mining Enterprises. Montana Bureau of Mines and Geology Bull. 90, March 1976, p. 218. (prepared under a grant from the U.S. Bureau of Mines).
>
> Meyer, R.F., and J.S. Carman (eds.). The Future of Small Scale Mining. A United Nations Publication, 1980, p. 501. (Proceedings of an international conference on the subject sponsored by the United Nations in cooperation with the U.S. Bureau of Mines and U.S. Geological Survey and held in Mexico, November 26 - December 5, 1978).

The reader is referred to both books as excellent guides to the practical problems facing the small miner, and the present study attempts to avoid unnecessary duplication of the material contained in them. Instead, with the 3 months available, a preliminary assessment of the status of milling and smelting in the Western States was made. An effort has been made to examine the economic impact of mining in seven Western States and to examine the major economic, regulatory, and political factors, both present and historical, that have influenced mining and mineral processing in this country. A brief examination of the state-of-the-art of process technology is also presented. In preparing for the study telephone interviews were conducted with most of the principal State government and private industry associations concerned with both major and small-scale mining in the West.

To reduce the scope of the study to a manageable level, the report concentrates on seven States—Arizona, California, Colorado, Idaho, Nevada, New Mexico, and Utah—and seven mineral commodities—antimony, copper, gold, lead, silver, tungsten, and zinc. Interviews showed that these seven minerals are the most active targets of the small prospector and miner. The "gold boom" of the seventies precipitated by gold prices of $150 to $850 per ounce led to placing a higher stress on activity in this area. Between 1961 and 1975 gold was being discovered at the rate of 260,000 ounces per year. Following the rise in prices, the rate of discovery between 1975 and 1981 increased to a phenomenal 2.4 million ounces per year. 1/The increased knowledge of the occurrence of gold gained through the discovery of the Carlin gold mine in Nevada also contributed to this higher rate.

1/ From statement of Dave Stevens, President, Minerals Exploration Coalition, before House Mines and Mining Subcommittee, November 10, 1981, Denver, Colo.

In the United States, exploration methods and the basis for subsequent development of hard rock minerals have undergone considerable evolution. From 1850 to 1900, the confirmation of mineralization based on a few high-grade surface samples was often adequate to convince individuals or fledgling mining companies of the potential existence of minable ore. In many instances, based solely on these data, mills were constructed and mining was begun. Quite often, tonnage proved to be insufficient and grade too erratic to support a profitable, long-term operation, capable of amortizing the investment. In some instances, however, through perseverance combined with improved technologies and economics, successful operations ensued and became the forerunners of many of our present-day major mining companies.

As mining companies began to expand their exploration efforts, emphasis moved from mineral deposits developed primarily on faith to those developed only after hard facts and data were acquired. An important factor in the changing scene was the realization that increased sampling decreased risk. In the steps leading to production, small prospectors and miners traditionally have played an important role in the search for exploration targets. However, these individuals usually do not have the resources to delineate the reserves necessary to amortize a mill and produce minerals and this often turn their properties over to larger mining companies. Currently, more than 50 percent of the major operating mines in the United States derive from exploration targets found by small prospectors. In some cases, small prospectors do not believe their prospects are large enough to interest mining companies, or the prospects have been turned down repeatedly by companies because of size or lack of interest in the commodities concerned. In these instances, the small prospector may decide to mine the resource on his own.

Options for subsequent processing of the ore are to arrange for custom milling or to assemble a small mill at or near the property. Although the custom milling arrangements may satisfy such a miner, if the ore is transported to a custom mill and the payment is less than expected, the miner usually believes that the mill is losing his values. Poor recovery may be part of the problem; however, the major culprit generally is the erratic occurrence of values in the rock hauled to the mill. For example, in the free milling of gold ore, the custom mill may originally make an adequate recovery, but as mining goes to greater depths, the nature of the ore changes from oxide to sulfide and the mill's recovery is less. At this point the small miner may decide to build his own mill, believing that he can do better than the custom mill, and also that if his property does not have enough ore, there are always other miners in the same situation who will haul ore to his custom mill.

The frequency of closure of these mills is high, again primarily because the erratic occurrence of values in the rock hauled to the mill does not lend itself to a profitable operation. Despite this, optimism among prospectors and miners is traditionally high, and through ownership changes or the construction of new mills, a continuity of the cycle is maintained. This generally ensures an adequate number of mills that are willing to handle custom ore in every active mining district.

In both the literature reviews and direct interviews conducted during this study, two common but avoidable problems of the small miner kept surfacing. First, he frequently depends on "ore' reserves that have not been adequately identified, and secondly he is often unrealistic in his planning and estimating of capital and operating costs.

With regard to mill and smelter processing terminology, the reader should be aware of the distinction between captive, toll, and custom processing. A "captive" plant processes material only from its own mines. "Toll" processing refers to a company A processing company B's material for a treatment fee and returning the end product to the original owner, company B, for sale as it chooses. In "custom" processing, the custom mill or smelter buys its feed material outright from another miner and then treats and sells the end product as it chooses.

III A Technologic Assessment

1. PROCESSING GOLD AND SILVER ORES

One of the most important advances in gold and silver hydrometallurgy since the introduction of cyanide leaching was the application of heap leaching to process low-grade gold-silver ores and small deposits of higher grade ore. The concept of heap leaching gold ores and supporting experimental work was described by the Bureau of Mines in 1969. This technology has been widely applied by the mining industry and many large-scale heap leaches are in operation. Although small heap leaching operations have not received as much publicity as the large-scale operations, the technology has enabled small operators to produce from deposits whose total value could not support construction of a conventional cyanide mill. Since the pregnant gold-silver solutions coming from heap leaching are too dilute for conventional zinc precipitation to recover the values, activated carbon is used to concentrate the precious metals. Although adsorption of gold and silver on activated carbon was known for a long time, the process was not used until 1952. Bureau research showed that gold-silver could be stripped from the carbon, that the carbon could be reused and that carbon adsorption was a practical method. The stripping solution and electrowinning cell described by Zadra[1] are currently used by many operators, both large and small.

Because stripping activated carbon with "Zadra solution" requires a long time at atmospheric pressure and temperatures below 100° C, the Bureau developed two alternatives to speed up the stripping step. A pressure stripping method was developed in 1973 which, by operating at temperatures above 100° C and under pressure, decreased the stripping time from days to hours. A desorption method using alcohol added to the NaOH-NaCN solution was developed in 1976 and also decreased the stripping time compared to standard Zadra solution. The Bureau built a trailer-mounted demonstration unit for carbon adsorption/alcohol desorption that could be moved to mining properties to demonstrate the technique. Pressure and alcohol stripping are widely used by both large and small operators in the mining industry.

The first commercial benefits resulting from the late 1960's Heavy Metals Program were achieved with the opening of the Nevada Cortez gold mine in 1969 and the startup of the Carlin gold mine mill in 1971, using a Bureau of Mines developed chlorine-oxidation process to treat carbonaceous gold ores. Two other important contributions to gold-silver processing by the Bureau were the development of an electrooxidation process to permit cyanidation of carbonaceous gold ores (1970), and the carbon-in-pulp process for treating high-slime ores (1971). Field demonstration units were built and operated at mine sites for both of these techniques, but are now inactive. The electro-oxidation process was never used commercially.

Recent research by the Bureau (1979) has applied heap leaching to materials that were previously considered untreatable, thus further helping both large and small miners put their properties into production. The technology, called agglomeration heap leaching, has been widely adopted by industry, and has been of particular interest to small miners and operators. Inquiries became so frequent that as a service to claim owners monthly seminars were scheduled at which the technique could be explained and participants given an opportunity to ask questions.

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[1] Zadra, J.B., A.L. Engel, and H.J. Heinen. Process for Recovering Gold and Silver From Activated Carbon by Leaching and Electrolysis. Bureau of Mines RI 4843, 1952, 31 pp.

Bureau efforts currently in progress also of potential benefit to operators of small mines include: (1) a report describing how to chemically refine zinc (Merrill-Crowe) precipitates to make a pure gold product; this information will primarily benefit the small operator by allowing him to make a more valuable product without the expense of smelting-refining furnaces; (2) studies to apply agglomeration heap leaching to old tailings, which are too low grade and/or small tonnage to support conventional reprocessing; (3) leaching gold and silver values from sulfidic ores or concentrates which will permit utilization of resources currently considered untreatable; (4) research to improve the desorption of gold-silver from activated carbon without resorting to pressure or a volatile, flammable solvent; and (5) studies to develop a processing sequence of countercurrent heap leaching to yield rich pregnant solutions from which gold-silver can be directly electrowon, thereby eliminating the carbon adsorption/ desorption step.

2. PROCESSING CONCENTRATES

a) Current Status

Processing sulfide concentrates (copper, lead, and zinc) requires smelter capacity that is beyond the financial capabilities of small miners or operators to install. This requires that existing smelters be used, and in this regard, seven smelters in the western United States were contacted to determine the availability of custom smelting services for the small operator. There are no zinc smelters currently operating in the western United States. The Bunker Hill zinc plant shut down about one year ago, because it was not receiving enough business to run economically, and the Bunker Hill lead smelter is in the process of shutting down. However, there are three custom copper smelters (Kennecott, McGill, Nev.; Phelps-Dodge, Douglas, Ariz.; ASARCO, Tacoma, Wash.), one custom lead smelter (ASARCO, East Helena, Mont.), and a custom smelter that accepts both lead and copper (ASARCO, El Paso, Tex.) that can be utilized by the small miner.

b.) Alternative to Smelting

A number of hydrometallurgical processes which are alternatives to traditional methods for treating base metal concentrates have been investigated. The Bureau has developed a ferric chloride leaching/fused-salt electrolysis process to recover lead from galena concentrates. The process has been tested through the miniplant stage and is a joint industry-Bureau of Mines cooperative effort. No commercial plant is in operation. A variation of the process has been developed by the French who recover lead from solution by aqueous electrolysis. There are a number of western deposits containing mixed sulfides of zinc, lead, copper, and iron, usually accompanied by small amounts of arsenic, antimony, bismuth, etc., and often silver. From such deposits it may only be possible or economic to prepare a mixed concentrate, thus making conventional processing impossible. Bureau of Mines research has resulted in a pressurized chloride-oxygen leach method of treating these complex sulfide concentrates that may be applicable to small operations. Chlorine, hydrogen chloride, or ferrous chloride are the usual sources of chloride, and lead to solution of the principal metal values as their respective chlorides. Most of the iron, the trace elements, and elemental sulfur remain in the leach residue. Selective precipitation, solvent extraction, crystallization, and fused-salt or aqueous electrowinning may be employed to recover individual metals from the solution.

The zinc roast-leach-electrowin (RLE) process, which combines pyro- and hydrometallurgical processing, is an established commercial operation and produces abut 80 pct of our zinc. However, there are no RLE plants operating in the western United States since the Bunker Hill operation closed.

A number of hydrometallurgical processes have been developed to treat copper concentrates. Only the Duval CLEAR process is currently being used to produce copper. The Lakeshore RLE process has been used but the plant was closed because of low copper prices. A commercial plant was built based on the Arbiter ammonia leaching process, but has not been used for full-scale production and is currently shut down. Pilot plant trails on a new oxidative electrolytic process said to be capable of converting chalcopyrite to copper metal, iron oxide, and elemental sulfur are claimed to be proceeding favorably. The Dextec process is being tested at a 0.25 mt/d of copper scale in New South Wales. The company calims that the method is also capable of treating complex sulfides of lead, copper zinc, and iron, and units are small enough to be located at the mine site.

Hydrometallurgical processes have the potential to be scaled down to relatively small plants; however, capital and operating costs are generally higher per unit of output than for smelting. Also, most hydrometallurgical plants are complex and require operators with a high level of technical training. For these reasons, it is not practical for most small operators to set up and run their own plants, even though the processes have been completely developed and proven successful.

The Bureau of Mines has started research to determine ways of upgrading base metal concentrates that are currently unacceptable to smelters because of their high arsenic content. Successful results may help some operators but will not solve the problem mentioned previously--that smelters will always take the best concentrate available to them. The Bureau is continuing research on several hydrometallurgical processes for treating base metal concentrates. However, for the reasons mentioned above, the small operator will not be in a position to set up and operate one of these processes. Hydrometallurgical processes offer even less opportunity than smelting for several small operators to get together and jointly operate a plant, because a hydrometallurgical plant must be tailored to a concentrate of fairly specific composition, and one plant might not be able to process several different concentrates.

c.) Tungsten

Although U.S. reserves of tungsten are estimated to be about 5 percent of world reserves, ores are low grade (usually averaging less than 1 percent WO_3) and deposits are frequently "pockety" and erratic. Thus many mines are worked only when prices and demand are high. Mineralization may be complex, so that expensive beneficiation and processing methods are required. Recent Bureau of Mines investigations have revealed an improved beneficiation method for low-grade tactite deposits and a calcine-quench-leach method for treating hot springs deposits.

d.) Copper

There are five hydrometallurgical processes for copper:

CLEAR (Duval).--Chalcopyrite is leached with a $FeCl_3$-$CuCl_2$ solution. Copper metal is electrowon from the resulting aqueous CuCl solution, which is simultaneously regenerated for recycle.

Arbiter Ammonia (Anaconda).--Chalcopyrite or chalcocite is leached with ammonia under pressure and oxidizing conditions. Copper is removed from the leaching solution by solvent extraction and electrowon from the aqueous strip solution. Ammonia is recovered for recycle.

RLE (Hecla-Lakeshore).--Chalcopyrite is roasted to convert it to $CuSO_4$, which is dissolved in dilute H_2SO_4. Copper metal is electrowon from the $CuSO_4$ solution. Sulfuric acid produced in the process must be disposed of.

Cymet.--Chalcopyrite is leached with a $FeCl_3$-$CuCl_2$ solution. CuCl is crystallized from the leaching solution, dried, and hydrogen-reduced in a fluidized-bed reactor. Copper metal and HCl for recycle are produced.

Sherritt-Cominco.--Chalcopyrite is roasted and iron is removed by a leaching-precipitation step. Copper is leached with H_2SO_4 under pressure, and copper metal is electrowon from the aqueous $CuSO_4$ solution.

e.) Black Sands

It has been known for many years that the so-called black sands from sand and gravel operations in Nevada and California often contain significant amounts of potentially recoverable minerals, plus precious metals. The Bureau of Mines investigated the potential for recovering valuable concentrates from such waste streams and worked out flowsheets applicable to several promising sources. Only relatively inexpensive, off-the-shelf beneficiating equipment would be required to recover such minerals as magnetite, chromite, ilmenite, zircon, and thoria, as well as gold, from the sands.

f.) Private Sector Services for the Small Miner

The introduction of this study discussed a small gravity mill and a large, completely portable unit, costing about \$6,500 and \$250,000 respectively. Other units, either fixed or portable and priced within this range, could be built to specifications tailored to the characteristics of the resource being considered for processing. Equipment needs and resulting costs would largely be dependent upon the capacity of the unit and the complexity of the processing sequence, and could best be determined by a consulting engineer.

Also, many equipment manufacturers maintain pilot plants where small-scale tests of various processing operations can be performed for a fee. Some also rent out small-scale equipment by the month. A useful list of manufacturers who might be consulted as to availability of such services is

> Chemical Engineering Equipment Buyers' Guide, published annually by McGraw-Hill Co., New York, as an adjunct to Chemical Engineering magazine.

Other sources of such information are advertisements in the trade journals, such as Engineering and Mining Journal, Mining Congress Journal, Mining Engineering, Mining Magazine, Skillings' Mining Review, and World Mining.

3.) COST DATA

Of vital concern to the potential mine or smelter operator are the costs associated with building and operating his enterprise. Two sources of such information that might be useful to the small operator are

> Handbook for Small Mining Enterprises, by F. N. Earll and others, 1976, 218 pp. Published as Bulletin 99 by the Montana Bureau of Mines and Geology.
>
> Capital and Operating Cost Estimating System Manual for Mining and Beneficiation of Minerals Except Fossil Fuels in the United States and Canada, by G. K. Clement and others, 1980, 149 pp. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Original study done by Straam Engineers, Inc., under Bureau of Mines contract J0255026.

In addition, the Bureau of Mines publishes cost evaluations for specific processes. Such reports are listed in the monthly/periodical New Publications--Bureau of Mines as soon as they are published. Lists of older material are issued annually, and a cumulative volume appears every 5 years; the most recent cumulation, covering 1975-79, was recently released, and older volumes are available for consultation at depository libraries for Bureau of Mines publications throughout the United States.

III B. Trends in Milling and Smelting

1. Mining and Milling Trends

The Bureau of Mines' newly developed Automated Mineral Information System was used to scan the Mineral Industries Location System (MILS) data base and summarize the seven selected commodities by type of operation. Table III - 1, summarizes the MILS data as "Past Producers," which includes those currently operating, and "all others."The "all others" category primarily includes developed but not yet producing deposits and a MILS flagging of explored and raw prospects. The MILS is a first-cut look at mineral locations; it does not distinguish between a Bingham Canyon-size deposit and a prospect hole and the data must be interpreted in that light. However, a large percentage of the past producer numbers relate to small-scale mining activity; i.e., the small near-surface deposit that was worked out or high-graded. The "all others" give some indication of the type of mineralization and localities in each State that would be the most likely targets of the small miner. Table III - 1 can be used to demonstrate among other things, the magical attraction of gold and silver to the small prospector and miner. It also is helpful in identifying where activity has taken place with respect to some of the lesser known but strategic stockpile materials such as antimony and tungsten.

An examination of Bureau of Mines Minerals Availability System and field office records was made as part of this preliminary assessment of milling trends during the period 1965 to 1979-81. The data, partly owing to their proprietary nature, were insufficient to establish any quantitative trends. However, several observations and conclusions can be made from the study.

- The majority of mills are captive.
- Most mills using gravity or flotation concentration can handle most gold, silver, sulfide, and tungsten (scheelite) ores. However, they will only treat custom ore when they can work it into their milling schedules. The mills prefer relatively homogeneous feed material and may be reluctant to accept different ore types or ores from different mining districts.
- The availability of custom mill capacity varies from State to State; for example, Nevada with over 3,000 tons per day of capacity has a much greater mill capacity than ore available. New Mexico, on the other hand, has been more heavily affected by mill closings in the past 15 years, and State officials report that the small miner has a problem locating custom milling facilities.

- Owing to poor economic and commodity price conditions the base metal sulfide (copper, lead, and zinc) mills have experienced the most closures.

- Most new mill openings have been gold and silver operations following the post-1973 precious metals price boom.

- Some of the small custom mills operate on an intermittent basis, opening only when sufficient ore is on hand or when prices are high enough for the mill to turn a profit.

- The increased use of heap leaching and carbon absorption recovery technology has reduced the percentage of gold mines still requring the services of a custom mill.

2. Smelting Trends

Table III-2 illustrates the declining trend in refining and smelting capacity between 1950 and 1980 for copper, lead, and zinc. In addition to producing all of the primary copper, lead, and zinc in the United States, these smelters produce about two-thirds of the Nation's primary gold and silver—Table III-2 vividly shows the overall loss in numbers of smelters as well as capacity from closures during this period.

The data for lead and zinc on Table III-2 do not include the loss of the recently closed Bunker Hill lead-zinc smelter. Industry officials cited the cost of complying with the Clean Air Act as the principal cause of the smelter closures and a resultant loss of their competitive edge over foreign producers. They also mentioned the burden of disposing of large tonnages of pollution control byproduct sulfuric acid for which there are no readily accessible domestic markets.

Robert A. Malone of Kennecott, in testimony before the U.S. House of Representatives Mines and Mining Subcommittee field hearing in Denver on November 10, 1981, cited a 1970 report to Congress from the Secretary of Health, Education and Welfare that estimated that the cost for all nonferrous smelters to achieve 98.8 percent SO_2 control would be $67.6 million. Malone went on to highlight the extent by which these original compliance costs were underestimated by the Government. Over the years 1970-80, the copper smelting industry alone spent over $1.1 billion on air pollution controls—over 16 times as much as the 1970 estimate. This $1.1 billion expenditure has led to an increase in average capture of SO_2 from 7 percent in 1961 to a current average of 60 percent, still short of the 98.8 percent mandated by the Clean Air Act.

TABLE III–1.—SELECTED SUMMARY OF THE STATUS OF MINING AND LEACHING ACTIVITY IN THE WESTERN UNITED STATES

[Number of locations]

State	Mineral	Past producers	All others
Arizona	Gold	1,603	708
	Copper	1,568	532
	Zinc	594	90
California	Gold	2,777	5,989
	Tungsten	114	206
Colorado	Gold	3,621	473
	Silver	2,985	456
	Lead	1,921	382
	Zinc	1,543	356
	Tungsten	226	6
Idaho	Gold	332	1,247
	Silver	358	897
	Lead	272	809
	Antimony	22	17
Nevada	Gold	1,125	406
	Silver	1,093	391
	Lead	486	181
	Tungsten	147	96
	Antimony	69	96
New Mexico	Copper	273	240
	Silver	355	296
Utah	Copper	677	132
	Lead	619	86
	Zinc	390	41
	Tungsten	72	35
	Antimony	23	3

Source: U.S. Bureau of Mines, AMIS/MILS December 1981.

TABLE III–2.—LEAD, ZINC, AND COPPER SMELTER AND REFINERY TRENDS, 1950–80

[Capacity units in thousand metric tons]

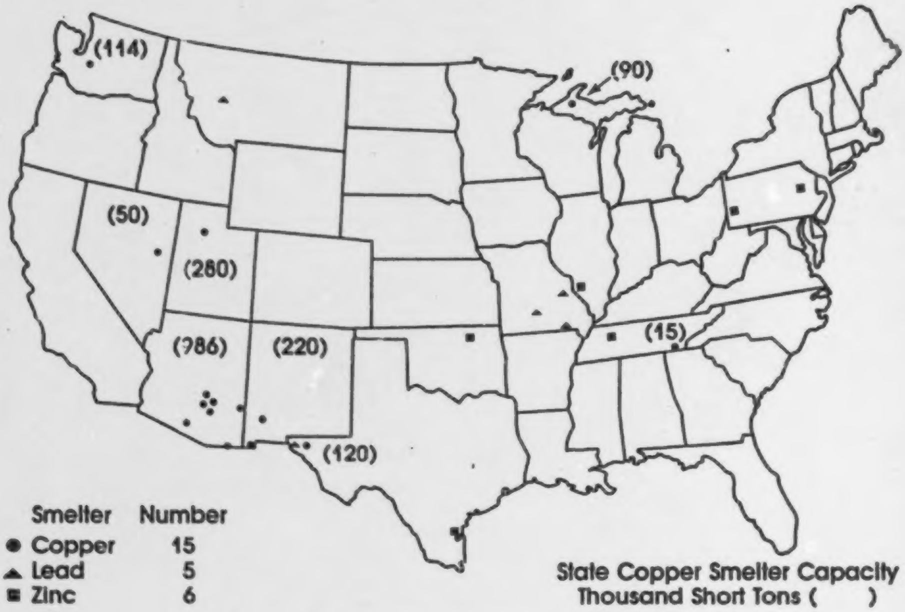
Commodity and facility	1950	1955	1960	1965	1970	1975	1980
Lead:							
Smelters:							
Number	10	10	9	6	8	6	6
Capacity [1]	1,200	1,200	1,300	900	1,400	714	714
Refineries:							
Number	9	9	7	5	6	5	5
Capacity [2]	900	900	668	600	710	714	714
Zinc:							
Smelters:							
Number	18	18	18	16	12	6	5
Capacity	947	1,056	1,057	1,099	1,052	591	[3] 478
Copper:							
Smelters: [4]							
Number	19	18	20	19	19	18	18
Capacity	2,050	2,020	2,120	2,080	2,110	2,060	1,970
Refineries:							
Number	13	13	15	16	16	17	15
Capacity	1,710	1,840	2,110	1,870	2,430	2,640	2,330

[1] Some smelter capacities through 1970 were reported as "charge" and metallurgical balances are not calculable with any degree of accuracy.
[2] Estimate.
[3] Includes 103,000 metric tons for Bunker Hill plant which will probably be dismantled in 1982 pending outcome of possible sale.
[4] Includes some secondary capacity of AMAX Smelter at Carteret, N.J.

Source: U.S. Bureau of Mines, March 15, 1982.

Figure 1

PRIMARY U.S. NON-FERROUS SMELTER LOCATIONS 1981


(114)
(90)
(50)
(280)
(986)
(220)
(120)
(15)
Smelter Number
● Copper 15
▲ Lead 5
■ Zinc 6
State Copper Smelter Capacity
Thousand Short Tons ( )

Source: D. Swan, Kennecott Corp., November, 1981

The impact of environmental requirements in the copper industry is even greater when one looks at the expenditures required for "total environmental, health, and safety compliance." Over the period 1970-79, pollution control expenditures in the nonferrous metals industry averaged nearly 18 percent of total capital expenditures. Comparable figures for iron and steel are 14.6 percent, electric utilities 8.1 percent, and all business 5.5 percent. According to recent Department of Commerce studies, the combined regulatory compliance costs for the copper industry for air, water, and worker health and safety regulations will total $4.5 billion in 1974 dollars over the period 1974-87. Air pollution controls account for the majority of these expenditures — $2.7 billion, all for control of smelter SO_2 emissions.

Malone and others indicated that the continuing requirement to meet Clean Air Act standards as currently written could led to the closure of 5 more copper smelters: the ASARCO plant in Tacoma, Wash. the Kennecott smelter at McGill, Nevada; the Inspiration smelter at Miami, Ariz. and the two Phelps Dodge smelters at Douglas and Ajo, Ariz. In conjunction with the Anaconda smelter that closed in September 1980, this would represent a loss of 36 percent of domestic copper smelting capacity.

With regard to the Anaconda smelter closing, Richard Krablin of the Anaconda Copper Co. subsidiary of Atlantic Richfield testified "that the closing was a straightforward business decision founded in economics. We simply could not justify spending the huge amount of capital necessary to bring the smelter into compliance with regulations for environmental and worker exposure protection. Economically, no retrofit or domestic smelter alternative could complete with tolling our concentrates to Japan. The Anaconda smelter was the victim of technology that was sufficient to produce copper, but not at a cost low enough to compete in a world market."

Included among the smaller smelters in the States studied, are the Union Carbide, Pine Creek, Ca. and Kennemetal, Fallon, Nev. tungsten smelters and some of the plants that are set up to process gold and silver concentrates into dore bullion. In addition concentrates are shipped from within the seven State study area to six main custom smelters: ASARCO's lead and copper smelters at El Paso, Tex., copper smelter at Tacoma, Wash. and lead smelter at East Helena, Mont., and Cominco Ltd's lead and zinc smelters at Trail, British Columbia, which is about 100 miles north of Spokane, Wash. Cominco is undertaking a major Can$700 million modernization and expansion at Trail that will increase lead and zinc capacities to 180,000 and 272,000 metric tons per year, respectively. Trail is well placed to absorb some of the custom lead-zinc and precious metal concentrates previously shipped to Bunker Hill.

III C. The Economics of Custom Milling and Smelting

1. Custom Milling

Although unavailability of custom mills can be a problem, a number of mining officials believe that the problem is, instead, the unavailability of ore to mill. There even may be an excess of custom mill capacity at present time. For example, although the Pride of the West appears to be the only custom mill currently operating in western Colorado, a number of mills not now offering custom service would do so if reasonable amounts of ore were available. Several entrepreneurs who have tried to offer custom milling have found the demand has not met their expectations and that they needed their own sources of ore for about 80 percent of mill capacity. The cost of custom cyanidation milling in Colorado is $35 to $40 per ton. The cost of milling lead-zinc ores are reportedly in a lower $3-16 range per ton. One mill operator requires 500 ton lots, another requires enough for about one week's mill operation to make it worthwhile to set up for a particular ore. For the small miner, an ore-buying facility that could purchase 10 to 50 ton lots would be of more benefit than more custom milling capacity. A panel of mining people under the sponsorship of the Colorado Mining Association is met February 10, 1982, in Denver to discuss feasibility of establishing an ore-buying station financed by several of the larger miners. An association of miners in Leadville is considering a cooperative milling venture.

With the relatively high percentage of small mining and milling activity revolving around gold, a specific look at practices in this area is in order.

The lack of custom milling facilities are nearly as critical today for many small gold miners as it was in years past, when gravity concentration and conventional vat leach cyanidation and amalgamation recovery practices were the only recovery methods used at local mills. However, with the recent advent of less complex mining and recovery techniques such as open pit mining, bulk haulage, heap leaching, and carbon absorption recovery, the number of gold mines requiring the services of a custom mill represents a much smaller percentage of the operating total. For many small miners, however, the costs or other requirements (e.g., favorable weather and terrain) of the newer recovery methods can not always be met.

Many small gold miners today operate on a seasonal or part-time basis, while others operate full time with a small crew. Consequently, at many small operations, shipments of ore to the concentrator are few and far between. In earlier years when there were many small mines producing, the combined volume of small shipments was sufficient to keep the local mill in business; infrequent shipments from more isolated mines could also be easily handled. When a particular mining boom subsided and mines closed, the local mill would be abandoned or put on standby status to await a resurgence of mining. When this occurred the entrepreneurs returned, rehabilitated the mill, and again serviced the local mines. Today, however, the prospective custom operator cannot always resurrect mills abandoned after earlier booms when gold was $20 to $35 an ounce and only rich ores and/or crude concentrates were processed. Instead he must provide a service capable of economically recovering gold from generally much leaner ores than those handled by previous operations. He must also be prepared to clear innumerable regulations (see Section III E), local codes, environmental hurdles, and increasing energy and labor costs and to counter the antipathy or even hostility of the people who now inhabit many of the old mining towns. High interest rates and a general decline in the availability of local rail transport facilities are universal roadblocks that may hinder the development of many small industries, including both mining and custom milling

2. An Alternative Approach to Custom Milling.—For many years the Bureau of Mines, both on its own and in concert with private industry, has been engaged in developing new gold recovery processes and improving existing recovery technology. Owing to this research combined with increases in gold prices, gold is being recovered from materials considered subeconomic several decades past. Although these developments have to a great extent reduced the complexity of the gold (and silver) extraction process, many small miners are apparently complaining that they have been denied an acceptable outlet for their product. Since in recent years custom mills have, for a variety of reasons, ceased to exist.

Heap leaching was initially developed for low-grade ores that could not stand the costs associated with conventional milling. Since many of these ores cannot bear the cost of transportation, heap leach piles can be set up at the mine site for a minimum cost in many instances. Currently in Nevada and Arizona, some operators run less than 50 ton heap leach piles. It is conceivable that the total capital costs for such an operation are less than a few hundred dollars. The equipment needed consists of a plastic tarp, a gasoline powered pump, several 50-gallon barrels, PVC pipe, cyanide and zinc dust. Once a day the barren cyanide solutions are pumped uphill to the gravity flow barrels. Using plastic irrigation hoses, the cyanide solutions are spread over the top of the run-of-mine heap, and percolate through the ore, disolving the gold on the way. The pregnant solution flows out the bottom of the heap through a zinc box, where the gold precipitates out, and into the barren sump for recycling. Each pass-through enriches the gold content in the zinc box. At the end of the cycle, the zinc is acidized and the remaining sludge is melted to flux to obtain impure gold (85 to 95%).

Where the ores are of high enough grade to transport but a custom mill is not available, it may be possible that small miners' associations etc. or trusted local entrepreneurs could, with guidance from the Bureau, profitably provide a basic heap leaching service in many gold mining districts since, very often, the ore bodies tend to be mineralogically similar. The type of operation suggested here would probably require that all of the small miners operating in a particular district, who wish to participate in a scheme such as this would, following a positive suitability evaluation of their ore, join together to form a cooperative venture. The members of a cooperative unit would then agree to deliver X amount of ore of an average specified quality and grade to a centrally located leaching facility prior to the beginning of a leaching cycle. Leaching cycles would vary from district to district depending upon factors such as leachability of the local ores, duration of the leaching season, and the anticipated quantity of ore involved . The participants of a leaching cycle or campaign would agree, prior to entry, to accept their share of the recovered products based on a precalculated rate of recovery less the operator's charges for services such as assaying, amenability testing, crushing, and agglomeration that may be required to prepare each member's ore for leaching and to aid in producing a heap having more or less uniform properties throughout. Fees would also be levied, proportional to a member's gross tonnage input, for the operator's costs associated with chemical and carbon regeneration, tailings disposal, regulations, overhead, etc. Metal values recovered in excess of the anticipated recovery should be divided proportionally between participants. New members wishing to join a cooperative would be required to wait until the beginning of a new leaching cycle before shipping their ore or, where year-around leaching is practical and multiple pads are available, they would agree to wait until sufficient ore from other mines was scheduled to arrive at the leaching site. Those miners producing ore that for one reason or another is not compatible with ores suitable for leaching (e.g., telluride ore) would have to seek alternate processing arrangements.

Firms that specialize in carbon stripping and other recovery processes associated with heap leaching would probably be attracted to cooperative ventures as described and would probably establish centrally located facilities to extract the precious metal values from the products of the leaching operations. This would reduce the capital cost requirements of the cooperative and probably lead to greater rates of efficiency and higher production.

The Bureau of Mines' role in these cooperative ventures could be to provide customary services such as technical advice and guidance, liaison with other Government agencies with which the cooperative must deal (EPA, USFS, BLM, etc.), and amenability-to-leaching tests on promising new, but refractory, deposits discovered in conjunction with the cooperative program.

In conclusion, if cooperative leaching facilities could be successfully developed as a practical alternative to custom milling services by a major segment of the small gold mining community, it could stimulate an interest in prospecting for gold and further the development of new mines. Since the individual gold prospector has historically been credited with the discovery of a large percentage of the world's economic deposits of other minerals, other segments of the domestic mining industry may also benefit from discoveries made as a result of such prospectors' activities.

3. Custom Smelting—Economic Considerations

At the present a shortage of zinc concentrates has led to a current and hopefully short-term situation where the combination of weak demand and concentrate shortage has resulted in an excess zinc smelter capacity despite the closing of zinc smelters as noted in the previous section.

A change in situation that has occurred since 1979 is that competition for ore and concentrates is much more intense. Large companies (and the Japanese) are now interested in small ore quantities they would not have bothered with several years ago.

This was a contributing factor in the closure of the Bunker Hill silver-lead-zinc operations, as noted by J.W. Kendrick, president of the Bunker Hill Co. at the November 10, 1981, House Subcommittee on Miner and Mining hearings in Denver. Bunker Hill had to depend on foreign concentrates for a large proportion of its smelter feed. In a concentrate seller's market Bunker Hill had to eliminate its labor and energy cost escalator clauses in order to compete for available concentrates with partially subsidized Japanese smelters. During the period 1977-81, Bunker Hill costs increased an average of 10.4 percent for labor, 11.0 percent for power, and 19.0 percent for natural gas while its rate of treatment charge increases was at 7.3 percent for purchased lead concentrates and at 4.6 percent for zinc concentrates.

Choice of smelter for a particular shipment appears to depend as much on how the shipper felt he was treated the last time as upon distance. Opinion of treatment received by smaller miners at the hands of the smelters ranges from "really bad" to "very good." Trail is said to pay for minor elements in the concentrates, whereas East Helena does not, but individual experiences are not uniform. Each shipper develops his own relationship with an individual smelter.

Smelter charges have been reported for ASARCO, East Helena, Mont., at about $140 per ton of concentrate and for Cominco, Trail, British Columbia at about $98 per ton of concentrate.

This variation in charges can be confusing to a small operator who has not dealt with a smelter before or who does not fully appreciate all the variables of assaying impurities and overhead charges that factor into a smelter contract. The two articles that follow have been selected to help explain the mine-smelter-consumer relationships. The first, excerpted from the Handbook For Small Mining Enterprises, explains the smelter contract from a small miners perspective. The second article, by ASARCO, explains the custom smelting business from the perspective of the largest custom smelter in the United States.

In addition a brief listing of representative smelter contract terms for a number of selected copper, lead, zinc, and tungsten smelters is presented in appendix A.

CUSTOM SMELTING

The impact of changing — and rising — costs experienced in recent years throughout all sectors of the American economy has been understandably reflected in the hesitancy of custom smelters to publish their rates and charges. Uncertainty about future costs makes it unreasonable under existing economic conditions to expect such schedules to be valid for more than a relatively short period of time. This situation is, of course, covered by the inclusion of the expression "subject to change without notice" in the smelter schedule.

Should a small-mine operator be interested in developing a specific property, it is recommended that he give active and continuing consideration to such factors as the expected quantity of ore from the property, the date the operation may commence, the origin of production, and the location of the closest shipping point. A complete chemical analysis together with a representative sample should be submitted to a custom smelter for its terms before the operator incurs additional development expense. After the smelter terms are received, he should be in a stronger position to assess the probable return for his particular mineral product.

The following statement, made several years ago, bears repetition, "Many small mine owners, on the other hand, could get more favorable terms if they would pay more attention to the making of their ore-selling contract. Although some fail to realize it, this may be as big a factor in the success of their enterprise as the intelligent development of the mine or the efficient extraction of the ore." (Spear and Wormser, 1925, p. 587.)

The shipment of crude ore or concentrate to a custom smelter provides a means whereby a person engaged in a small mining operation may receive some payment toward his expenses as he proceeds in his mining activity. Although smelter ore-buying contracts may be complex, they are not inexplicable.

The smelter, which is expensive to establish, may need a mixture of ores from a variety of mines in order to provide the ingredients essential for a satisfactory smelter charge. Moreover, the smelter must have adequate supplies of ore to assure a continuing and uniform level of operation, because the smelter should perform at full capacity to provide for maximum distribution of its overhead or fixed costs. A smelter must receive enough return to smelt ore and concentrate, to refine the metal produced, and to deliver the final product to an established market.

Each custom smelter is different, and each must consider the proposed product's suitability to its particular process as well as the amount of metal recovery, its costs of supplies, and its distance from refineries or markets.

Generally speaking, a smelter schedule details those ore constituents for which payment will be made and designates the deductions to compensate for the loss of metal in the smelting process. Also included are the specific sources upon which initial price would be quoted. Additionally, the schedule details the deductions the smelter may make for demurrage, for treatment charges, for the presence of totally unwanted constituents, for excessive moisture, for charges to cover required pollution-control expenses, and for import duties, taxes, and surcharges. Changes in the base labor rate and the cost of freight to market, as adjusted to coincide with upward or downward major variations in these rate provisions, may also be specified. Other provisions may include the definition of quotations and settlement as well as requirements relating to mode of transport by rail car. All of these specification and requirements will vary, depending upon the needs and processes of the specific smelter.

Schedule provisions denoting unusual situations may prevail. For example, White Pine Copper Company, White Pine, Michigan, allows for the effect of winter freezing by stipulating that if the buyer (smelter) undergoes unusual demurrage or unloading expenses in that particular season because of the irregularity of shipments or the frozen condition of the ore in the rail cars, the buyer can suspend shipments pending restoration of normal shipping conditions. Moreover, during that same period of November 1 to April 1, concentrates are to be shipped in insulated cars if these are available. Additional escalating charges for uncontrolled increase of moisture during those months are also specified.

Payments for contained copper, silver, gold, and silica are detailed, based on specified "Metals Week" prices. The schedule, which details pertinent provisions, contains the stipulation that it is subject to change without notice.

Company procedure to determine the acceptability of crude material necessitates the shipment of a representative sample to the Reduction Department. If, after analysis, the material is judged to be acceptable, the Department authorizes shipment of a trial lot, which is subject to additional analysis. If the material again proves acceptable, the Reduction Department prepares a quota arrangement governing shipments to the smelter.

The Department advises that compliance with this procedure be undertaken as soon as possible in the development of the property, because conditions other than the chemical and metallic analysis of the material could affect the ability of the smelter to continue receiving that material.

From: F. N. Earll, et al. Handbook For Small Mining Enterprises. Montana Bur. of Mines and Geol. Bull. 90, March, 1976 p. 168-171.

Shipments to the smelter should be made in flat-bottom gondola cars or end-dump trucks, but the shipper must realize that these shipments will not be accepted unless prior arrangements have been made between smelter and shipper. The Department reserves the right upon its written notice to the shipper to restrict or stop any or all shipments.

Examples of the general arrangement, terms, and specifications of schedules for both lead concentrates and copper concentrates follow, together with deriviations of smelter values for both concentrates based upon the schedule provisions. Also presented are examples of a smelter's general clauses governing all open schedules.

LEAD CONCENTRATES

Analysis	**Price** (1976)
Au — 0.03 oz./T.	$150/oz.
Ag — 200 oz./T.	$4.50/oz.
Cu — 0.2%	85¢/lb.
Pb — 60%	24.5¢/lb.

Payments	
Au — (.03-.02) (.925) = .00925 ($150.00-$.50) =	$ 1.38
Ag — (200-1) (.95) = 189.05 ($4.50-$.06) =	839.38
Pb — (60-1.5) (.95) (20) = 1111.5 ($.245-.047) =	220.08
Cu — No payment	
	$1060.84/ton
Base charge $35/ton	
Assume no escalation in labor	
Assume no change in bullion freight rates	
F.O.B. smelter value	$1025.84/ton

NOTE: Freight to smelter is for the account of the mine.

COPPER CONCENTRATES

Analysis	**Price**
Au — .002 oz./T.	$150/oz.
Ag — 3.0 oz./T.	$4.50/oz.
Cu — 25%	85¢/lb.

Payments	
Au — No payment	
Ag — (3-1) (.95) = 1.9 ($4.50-.06) =	$ 8.44
Cu — (25-1) (.975) (20) = 468 ($.85-.076) =	$362.23
	$370.67/ton
Base charge $35/ton	
Assume no escalation in labor	
Assume no change in bullion freight rates	
F.O.B. smelter value	$335.67/ton

NOTE: Freight to smelter is for the account of the mine.

SMELTER SCHEDULES

PURCHASE SCHEDULE #__________

DATE EFFECTIVE [illegible]

SHIPPER__________ ADDRESS__________

MINE__________ LOCATION__________

PRODUCT LEAD CONCENTRATES R. R. STATION__________

The following purchase terms are subject to the General Clauses shown on the back of this sheet, and are subject to change on 30 days notice. Unless shipments are begun within 30 days this quotation is automatically cancelled.

DELIVERY: F.o.b. rail cars at unloading bins of the Buyer's Plant. The rates quoted are based on shipment in open top gondola equipment. Extra unloading charges of up to $2.00 per wet ton will be assessed for product received in other equipment.

PAYMENTS

GOLD: Deduct 0.02 troy ounces per dry ton and pay for 92.5% of the remaining gold content at the daily London Final Gold Quotation, as published in Metals Week, averaged for the calendar month following date of delivery of product, less a deduction of 50¢ per troy ounce of payable gold. All purchases of gold will be subject to United States Governmental regulations pertaining to transactions in gold.

SILVER: Deduct 1.0 troy ounces per dry ton and pay for 95 % of the remaining silver content at the Handy and Harman New York Quotation for refined silver averaged for the calendar month following date of delivery of product, less a deduction of 6.0 ¢ per ounce.

LEAD: Deduct from the wet lead assay 1.5 units and pay for 95 % of the remaining lead at quotations for common domestic lead for delivery in New York as published in Metals Week averaged for the calendar month following date of delivery of product, less a deduction of 4.7 ¢ per pound of lead accounted for. The quantity of lead not paid for shall equal a minimum of 3.0 units per net dry ton.

COPPER: Deduct from the wet copper assay 1.3 unit and pay for 97.5 % of the remaining copper at the daily net domestic refinery quotations for electrolytic wire bars as published in the Metals Week averaged for the calendar month following date of product, less a deduction of 13.0 ¢ per pound of copper accounted for. Nothing paid for copper if less than 2.0 % by wet assay.

NO PAYMENT WILL BE MADE FOR ANY METAL OR CONTENT EXCEPT AS ABOVE SPECIFIED.

DEDUCTIONS

BASE CHARGE: $ 35.00 per net dry ton of 2,000 pounds.

LABOR: This quotation is based upon an average hourly cost of employment of $ 7.00 at Buyer's Plant. To adjust, increase or decrease Base Charge by 0.5¢ for each 1¢ per hour that the average hourly cost of employment at Plant during the calendar month prior to the date of delivery of product is greater or less than $7.00, fractions in proportion.

ARSENIC: Allow 0.5 units free; charge for excess at $ 0.75 per unit) FRACTIONS
ANTIMONY: Allow 0.5 units free; charge for excess at $ 1.00 per unit) IN
BISMUTH: Allow .05 units free; charge for excess at $ 0.50 per lb.)
NICKEL: Allow .3 units free; charge for excess at $ 2.00 per unit) PROPORTION

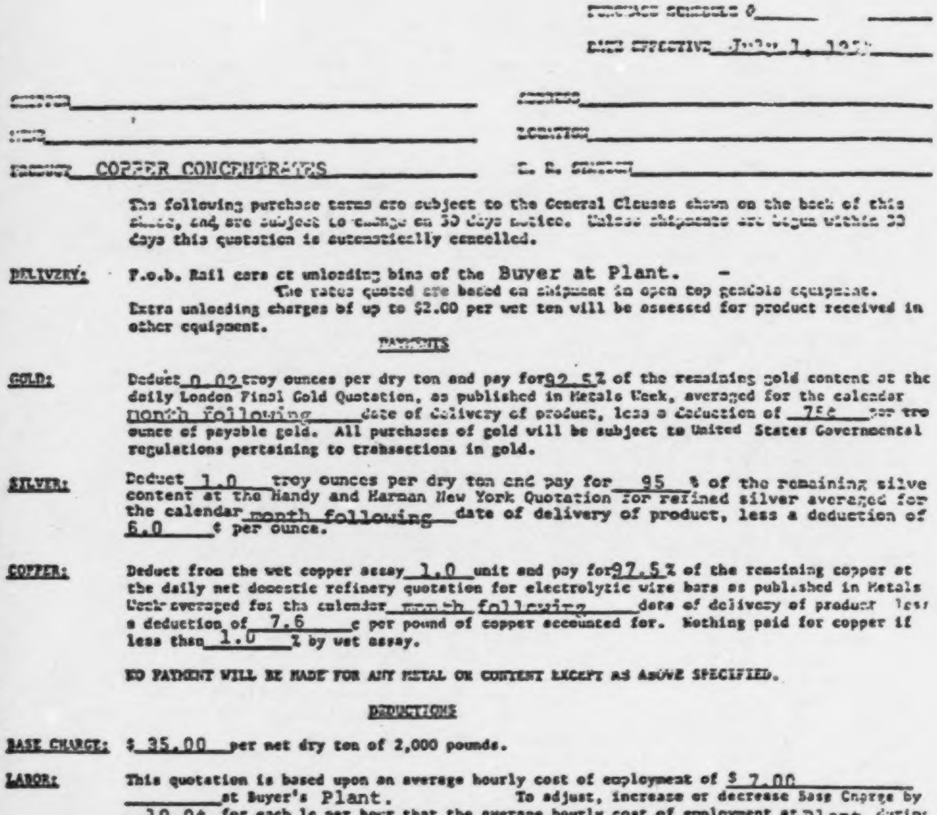
TAXES: See Clause 1 on reverse side of this schedule.

FREIGHT: All railroad freight and delivery charges for account of Shipper. Deduct from settlement freight and other advances made by Buyer.

FREIGHT BULLION: This schedule is based upon a published 50 ton carload freight rate on lead and copper bullion of $41.26 and $37.57 respectively.

TONNAGE: Limited to__________ tons per month.

By __________



PURCHASE SCHEDULE 0______ ______

DATE EFFECTIVE July 1, 19[illegible]

SHIPPER______ ADDRESS______

MINE______ LOCATION______

PRODUCT COPPER CONCENTRATES R. R. STATION______

The following purchase terms are subject to the General Clauses shown on the back of this sheet, and are subject to change on 30 days notice. Unless shipments are begun within 30 days this quotation is automatically cancelled.

DELIVERY: F.o.b. Rail cars at unloading bins of the Buyer at Plant. - The rates quoted are based on shipment in open top gondola equipment. Extra unloading charges of up to $2.00 per wet ton will be assessed for product received in other equipment.

PAYMENTS

GOLD: Deduct 0.02 troy ounces per dry ton and pay for 92.5% of the remaining gold content at the daily London Final Gold Quotation, as published in Metals Week, averaged for the calendar month following date of delivery of product, less a deduction of 75¢ per troy ounce of payable gold. All purchases of gold will be subject to United States Governmental regulations pertaining to transactions in gold.

SILVER: Deduct 1.0 troy ounces per dry ton and pay for 95 % of the remaining silver content at the Handy and Harman New York Quotation for refined silver averaged for the calendar month following date of delivery of product, less a deduction of 6.0 ¢ per ounce.

COPPER: Deduct from the wet copper assay 1.0 unit and pay for 97.5% of the remaining copper at the daily net domestic refinery quotation for electrolytic wire bars as published in Metals Week averaged for the calendar month following date of delivery of product less a deduction of 7.6 ¢ per pound of copper accounted for. Nothing paid for copper if less than 1.0 % by wet assay.

NO PAYMENT WILL BE MADE FOR ANY METAL OR CONTENT EXCEPT AS ABOVE SPECIFIED.

DEDUCTIONS

BASE CHARGE: $ 35.00 per net dry ton of 2,000 pounds.

LABOR: This quotation is based upon an average hourly cost of employment of $ 7.00 at Buyer's Plant. To adjust, increase or decrease Base Charge by 10.0¢ for each 1¢ per hour that the average hourly cost of employment at Plant, during the calendar month prior to the date of delivery of product is greater or less than $7.00 fractions in proportion.

ZINC: Allow 5.0 units free; charge for excess at $ .30 per unit) FRACTIONS
ARSENIC: Allow 0.5 units free; charge for excess at $ 1.00 per unit)
ANTIMONY: Allow 0.2 units free; charge for excess at $ 1.50 per unit) IN
BISMUTH: Allow 0.05 units free; charge for excess at $ .50 per lb.)
NICKEL: Allow 0.3 units free; charge for excess at $ 5.00 per unit) PROPORTION

TAXES: See Clause 1 on reverse side of this schedule.

FREIGHT: All railroad freight and delivery charges for account of Shipper. Deduct from settlement freight and other advances made by Buyer.

FREIGHT BULLION: This schedule is based upon a published 75 ton carload freight rate on lead and copper bullion of $32.31 ~~and~~ -------------- ~~respectively~~.

TONNAGE: Limited to______ tons per month except by special arrangement.

SMELTER SCHEDULES

GENERAL CLAUSES GOVERNING ALL OPEN SCHEDULES

1. TAXES: All taxes or other governmental charges, national, local or municipal, now or hereafter imposed in respect to or measured by the product purchased hereunder, or the production, extraction, smelting, refining, sale, transportation, proceeds or value thereof, or of the metals derived therefrom, other than income taxes levied upon the BUYER, shall be for account of the SELLER and shall be deducted from the purchase price payable hereunder.

2. SAMPLING: Weighing, moisture and ore sampling (at which Seller or a representative may be present) as done by Buyer according to standard practice, promptly after receipt of product, will be accepted as final. The absence of Seller or a representative shall be deemed a waiver of the right in each instance. After sampling, the product may be placed in process, commingled, or otherwise disposed of by Buyer.

3. ASSAYING: As soon as available Buyer will furnish a pulp sample to Seller, or to Seller's representative or the firm handling Seller's assay work. On Seller's request Buyer will make assay comparison with Seller, or his representative by exchange of assay certificates over the counter. Comparison may be made by exchange of certificates through the mail, and in such event Buyer and Seller will mail to each other their respective assay certificates on the sixth day following date appearing on smelter pulp sample envelope, or other such date as may be agreed upon. The following splitting limits will be used for comparison of assays under either exchange method listed above:

Gold	.02 troy ounce per ton	Arsenic	0.5%
Silver	.5 troy ounce per ton	Antimony	0.2%
Lead	0.5%	Bismuth	0.02%
Copper	0.3%	Nickel	0.1%
		Zinc	0.5%

   If assays of Buyer and Seller are within limits above specified, settlement assays will be determined by averaging the two results. If assay comparisons indicate differences greater than the above limits, control sample shall be submitted to umpire. Umpires shall be selected in rotation from a list mutually agreed upon whose assays shall be final if within the limits of the assays of the two parties; and if not, the assays of the party nearer to the umpire shall prevail. Losing party shall pay cost of umpire. In case of Seller's failure to make or submit assays, Buyer's assays will govern.

4. The rates quoted herein are for carload lots. On truck shipments and/or any lot containing less than 20 tons there will be a handling charge of $25.00.

5. In this schedule where the word "ton" is used, it is understood to be a ton of two thousand pounds avoirdupois; where the word "ounce" appears, as referring to gold and silver, it is understood to mean the troy ounce; and where the word "unit" is used, it is understood to mean one percent of a ton, or twenty pounds avoirdupois.

6. The rates quoted herein are based on present published all rail freight rates on copper bullion from plant to New York City. Any increase or decrease is for account of Seller and proper deduction or credit will be made accordingly.

7. Seller should consign his shipment to -- Buyer, Plant location. It is required that the original bill of lading covering each such shipment be delivered to the Buyer promptly on release of the shipment to the carrier. Full details as to the disposition of settlement returns, including royalty instruction if any, must be furnished by Seller to Buyer before shipments can be processed.

8. Performance of this agreement is subject to any delays caused by strikes or other disabling causes beyond the control of either party.

9. All freight and other charges paid by Buyer for Seller's account will be considered as an advance payment and will be subject to an interest charge. Such interest shall be charged from the date of the advance payment to the date of final settlement at a rate of 1.2 times the rate quoted to Buyer from time to time by the bank.

CUSTOM SMELTING AND REFINING

Asarco's original business, custom smelting and refining, remains a core of the Company's business today. The Company's strong integrated and interrelated smelting and refining complex makes it the world's largest custom processor of nonferrous metals.

A pure custom smelter and refiner, as differentiated from an integrated miner and producer of metals, would have one or more smelting and refining plants, an ore purchasing department, and a metal marketing organization; but it would not own or operate any mines. It would buy ores and concentrates from mines not large enough to support their own integrated processing and marketing facilities and residues, slags, sludges, flue dusts and other metal-bearing materials from metal processing plants that produce a finished product but do not recover by-products. These crude products of mines or by-products of processing plants would be purchased on a smelting and refining schedule, that is, the seller would be paid for his products and the custom smelter and refiner would own them outright.

The custom smelter and refiner would then convert this mixture of raw materials into refined marketable metals and endeavor to sell them for enough to cover the price paid to the seller, processing expenses, plus an adequate profit.

In addition to the technical and physical problems of performing its tasks, a custom smelter and refiner has two principal commercial problems: One, correlating the unit price paid for the metal content of the raw material with the price eventually received for the resulting refined metals, which normally are not available for sale until two to three months later, and two, being able to sell to the market the amount of metal purchased.

The first problem is imperfectly dealt with by basing the unit purchase price of the contained gold, silver, lead, copper, or zinc on some published quotation such as, in the case of copper, the London Metal Exchange, the Commodity Exchange, or the price quoted by primary producers, as published in Metals Week, and using a quotational period far enough in the future to coincide with the time that the refined metal produced therefrom is expected to be available for sale. When making these purchases, deductions of metal content, a smelting charge and other charges are made to cover the costs of processing and to provide for metal losses and an adequate profit. The difference between the gross market value of the contained metals less a refining and delivery to market charge and what is paid the shipper is called the margin.

The second problem, that is, being able to sell the amount of metal purchased, is even less perfectly dealt with by trying to sell each day or week or month the same amount of gold, silver, lead, copper, or zinc that is purchased or priced during the same period. Asarco uses LIFO (Last In First Out) inventory accounting at its smelters and refineries. It has a pipeline or base supply of metals in process. The pipeline was established years ago and is part of the Company's working capital. As Asarco buys additional metal—that is, receives metal in the front end of the pipe—it tries to sell an equal amount of metal which is pushed out of the other end of the pipe.

Asarco tries to sell each month the same amount of metal that it purchases and tries to buy and sell at the same quotation. When the system works it is an effective hedge and protects the Company's smelting and refining margins. However, because of the cyclical nature of the nonferrous metals business, it doesn't always work.

What happens in the down phase of the cycle is that the raw materials and their component metal content continue to be purchased at published quoted prices but because of reduced demand, sale of an equal amount of metal cannot be made. The purchase arrangement is contractual. Asarco has agreed to buy a certain product, described as to quality and quantity, during a designated period of time, usually a year or several years. The metal component is priced on a published quotation using a designated quotational period. Asarco has a contractual obligation to buy and the seller has a contractual obligation to sell. So the Company continues to buy raw materials and operate its plants, but being unable to sell an equivalent amount of metal, it accumulates metal inventory at the unit prices paid for the metal. At recent average prices one ton of accumulated copper represents approximately $1,700 of working capital; a ton of lead, $700; and a ton of zinc, $900. Gold and silver, even though they are high priced, are not a problem in this regard. The precious metals market is governed by different factors and these metals can always be sold readily. In their case the principal concerns are to keep the metal flowing through processing currently so that physical refined metal is available for sale as scheduled, and to avoid tying up working capital in material in process.

When Asarco accumulates metal it is usually because demand is less than supply. When this is so, the quoted prices are under pressure. If the Company must continue to buy metal at the quoted price but can't sell at it, the recourse is to lower the price. This has a dual effect. It tends to establish a price level which will balance demand with supply, and, in any event, it lowers the price at which metal is accumulated. In the long term the lower price tends to discourage production and thereby reduce supply.

Custom smelters and integrated producers react differently when markets are weak. The custom smelter buys its intake at the published price, whereas the integrated producer has only invested its costs of production. There is then a tendency for the integrated producer to discount from the published price to maintain sales rather than reduce prices. The custom smelter, on the other hand, has to protect the integrity of the quotation to keep from providing an umbrella under which discounting can take place and to bring his selling price and buying price to the same level. In this sense the custom smelter is more sensitive to the quality of the published prices and tends more quickly to reduce its published prices in weak markets.

In the up phase of the cycle, demand may increase more rapidly than supply. During this phase, the custom smelter may be able to recoup some of the losses and carrying costs incurred during the down phase of the cycle. Just as it tends more quickly to reduce prices in weak markets, the custom smelter may be the first to react by increasing its prices when markets are strong.

The above applies to a pure custom smelter. While Asarco at one time could be so described, it is, of course, today a mixture of custom smelter and integrated producer, and the mix varies with the metal—copper, lead, zinc, or silver (see page 17).

In the case of Asarco's own mines, because of historical development and because others share in the proceeds of some of these mines, the Company internally purchases such mines' products as if they had been sold to it by outsiders. The purchase agreements are arms-length transactions and reflect terms and conditions available in the general market. The metals are part of the Company's intake which is sold by Asarco's Sales Department. For these reasons Asarco accounts for the metals from its own mines as custom purchases, although these purchases really have the characteristics of integrated production.

Another category of custom smelting and refining is toll, whereby material delivered by others is smelted and refined, or just refined, for a processing fee, and the resulting refined metal is returned to the owner. In the case of toll metals, the price risk is borne by the shipper.

Smelting and refining facilities are necessary to get the products of Asarco's own mines to market. The Company's custom and toll activities broaden this required base and provide an economy of scale not available without them. To express it another way, a profitable stand-by-itself custom smelting and refining complex provides an attractive incremental cost benefit to the processing of products from Asarco's own mines.

From an address to securities analysts by Asarco President R. L. Hennebach, October 1978. Figures have been updated to June 1981.

III D. Transportation

The closure of some of the major western smelters over the past two decades or so has probably affected the smaller mines to a larger extent than the major mine and mill operators. For example, the shutdown of the Leadville, Colo. smelter in 1960, the Selby, Calif. smelter in 1970, and the Kellogg, Idaho, smelter in 1981 has added 200 to 1,000 miles to the distances concentrates have to be transported to the replacement custom smelters (appendix B). While there are some (see page 54) economies gained in long-distance rail transport, the small miner often does not have enough volume to take advantage of them. In interviews conducted by the Bureau's Denver Field Office it was found that for Colorado mills trucks are the preferred form of transportation, moving perhaps 75 to 80 percent of material shipped. One medium-sized operator said transportation of concentrates to a smelter comprised about 15 percent of cost—about $2,600 to $3,000 for a single contract truck shipment of about 20 tons from the San Juan area to East Helena. One large mine in the same area ships its concentrates 100 miles by truck to a major railroad center, Grand Junction, then by train to El Paso. A Boulder County operator who trucks his concentrates to Trail, British Columbia or East Helena, Mont. says the amount that Cominco in Trail pays for the minor amount of zinc in his concentrates (which ASARCO does not pay for) pays his transport cost.

A recent, (1980) Bureau of Mines study [1] examined the impact of U.S. rail abandonment on the nonfuel minerals industry. In identifying the problem areas, the study points out that considerable interdependence exists between rail transport and mineral shipping in the United States. Raw and processed nonfuel mineral materials account for approximately one-third of U.S. rail freight tonnage and almost one-fifth of rail company gross freight revenues. Railroads, in turn, are significant to the U.S. minerals industry. For example, when measured in ton-miles, domestic railroads account for the transport of about 25 percent of ferrous ores, 90 percent of nonferrous ores, 40 percent of nonmetallic minerals, 50 percent of iron and steel, 75 percent of primary nonferrous metal products, and 65 percent of stone, clay, and glass products.

In recent years, U.S. rail shipments including mineral freight have been subjected to increased rail line closings throughout the country. This termination of service (referred to as "abandonment") is becoming a more frequent means of reducing revenue losses by domestic railroad companies. The study methodology was based principally on a survey of 200 rail freight records and on statistical tests that correlated 2,000 points in the Bureau's Mineral Industry Location System (MILS) with 700 prospective abandonments throughout the United States. The study conclusions were as follows.

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[1] Balazik, R. The Impact of U.S Railroad Abandonment on Domestic Mineral Industries Bu. Mines IC 8834, 1980, 18 pp.

Table III H-1. — **Characteristics of prospective rail line abandonments and mineral site impacts as of 1978**

State[1]	Number of lines	Mileage	Percent of state trackage	MILS [2] points in impact areas
Arizona	1	64	3.2	0
California	17	252	3.5	126
Colorado	3	67	2.0	9
Idaho	12	307	11.7	125
Nevada	5	136	8.7	57
Utah	1	2	0.1	0

[1] New Mexico had no proposed rail abandoments.
[2] MILS = U.S.B.M. Mineral Industry Location System.

Source: IC 8834.

1. Raw and processed nonfuel minerals probably will comprise a large percentage of the traffic disrupted by the abandonment of rail lines in the next few years. However, the actual mineral tonnage involved will be small compared with total domestic mineral traffic and will be distributed over many lines. Most of the mineral freight will be accounted for by fertilizer materials carried within agricultural regions and by relatively low-value minerals (rock, sand, gravel, etc.), which are normally moved short distances. Thus, local short-haul producers and/or shippers will be affected.

2. Instances of hardship on some small mineral shippers already have resulted from abandonment. Moreover, adverse impacts on mineral producers that were important to their local economies were observed frequently enough to suggest a need for safeguards that would mitigate the effects of abandonment disruption.

3. Although a great number and variety of mineral sites were identified in the abandonment impact areas, statistical analysis did not indicate a strong coincidence of MILS mineral sites and prospective rail line abandonments. Thus, the occurrence of MILS sites in the impact area does not appear to be the result of abandonments focused on mining and mineral-processing areas.

4. The predominance of inactive mineral prospects and closed mining facilities in many abandonment impact areas, principally in Western States, suggests that abandonment could significantly reduce the opportunity to develop new resources or reopen defunct mining operations in those areas.

5. Despite the problems noted above, this study did not discern any long-term abandonment trends with national or broad regional dimensions that would require major shifts in transport modes for nonfuel minerals. This conclusion assumes no acceleration in the pace of abandonment proceedings and no major alteration in the current geographic pattern of abandonment.

A study conducted under contract to the Bureau forecast developments in domestic minerals transport.[2] The following excerpts from this report, while reflecting 1974 to 1977 data, serve to describe the factors affecting the rail and truck haulage of metallic minerals.

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[2] Wunblatt, H., and D. Matzzie. (Consad Research Corp.). Forecast of Development in Domestic Minerals Transport. Bu. Mines Open File Rept. 4-78., 1977, 230 pp.; available for consultation at the Bureau of Mines Filed Operations Centers at Pittsburgh, P., Denver, Colo., and Spokane, Wash.; at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.; and from the National Technical Information Service, Springfield, Va. PB 276 560.

2.0 RAIL TRANSPORT

2.1 Industry Structure

The Interstate Commerce Commission (ICC) classifies railroads as line-haul railroads or switching and terminal companies, and it also classifies them on the basis of revenues: Class I railroads have average annual revenues of at least $10 million; Class II railroads have revenues of less than $10 million.

As of April 1977 there were 58 Class I line-haul railroads.[1] These railroads operate 94 percent of this country's railroad mileage and haul about 99 percent of the traffic.[2] In addition, there are 24 Class I switching and terminal companies and about 250 Class II railroads presently in operation.[3] This last category includes railroads ranging in size from ones which are owned and operated by a husband and wife to ones which had been classified as Class I railroads until the revenue minimum for Class I railroads had been increased from $5 million to $10 million in January 1975.

Eighteen railroad holding companies own or control 35 Class I line-haul railroads as well as a number of other railroads, and another fifteen Class I line-haul railroads have some form of affiliation with other American railroads, Canadian railroads, or industrial firms. This last category includes three railroads owned by U.S. Steel (the Bessemer and Lake Erie; Duluth, Missabe and Iron Range; and Elgin, Joliet and Eastern). Also, a large Class II line-haul railroad (the Lake Superior and Ishpeming) is controlled by Cleveland Cliffs Iron. Many Class II railroads as well as both Class I and Class II switching and terminal companies are owned by industrial firms and usually operated primarily to serve the company's mines or plants.

As a result of mergers, consolidations and bankruptcies, the number of railroads has been declining for over half a century. There were 513 operating railroads in 1946 and only 331 in 1973.[4] A proposed consolidation of some significance is the purchase of the Green Bay and Western by the Burlington Northern. This purchase is being contested by three other railroads, which have developed a competing offer; and a railroad-supply firm has also recently entered its own bid.

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[1] Association of American Railroads, Yearbook of Railroad Facts, 1977 Edition, Washington, D.C., 1977, p. 2.

[2] Moody's Investors Services, Moody's Transportation Manual, New York City, 1976, p. 6.

[3] Ibid., pp. a5 - a7.

[4] Ibid., pp. a4 - a5.

Tables 2.1 and 2.2 present 1974 data on railroad carriage of non-energy minerals and selected mineral products. For each commodity, the tables show annual traffic volume and freight revenue, as well as average load per car, average length of haul, and average revenue per ton-mile. The largest volumes shown in the tables are for iron ores, primary iron and steel, iron and steel scrap, crushed and broken stone, sand and gravel, and phosphate rock.

The average revenue per ton-mile shown in the tables is seen to have ranged from 1.10 cents for sulfur to 3.62 cents for iron and steel scrap, and 3.75 cents for glass and glass products. These values may be compared to an average of 2.27 cents for all traffic. In general, revenue per ton-mile tends to vary inversely with length of haul, shipment size, and loading per car, and to vary directly with commodity value and value of loss and damage claims. Higher rates are also charged for shipments requiring specialized railroad equipment or which tend to damage railroad equipment. This last consideration is a contributory factor in the relatively high rates charged for shipping metal scrap.

Average length of haul is seen to vary from 70 miles for phosphate rock to 1130 miles for primary aluminum smelter products. The short average lengths of haul shown for phosphate rock, copper ores and iron ores are primarily the result of a few heavy-volume short-distance movements: from phosphate mines in Florida's Bone Valley to Tampa; from the iron ranges surrounding Lake Superior to the various lake ports; and a 17-mile movement from an Arizona copper mine to a concentrating mill. The average lengths of haul shown in the tables may be compared to the average for all traffic: 432 miles.

The average load per car is seen to vary from 24.8 short tons for glass and glass products to 97.3 tons for copper ores, with most minerals which can be shipped in bulk towards the upper end of this range. These values may be compared to the average for all shipments which is 58.9 tons.

BuMines OFR 4-78 p.18

Table 2.1: Railroad Data for Metals and Primary Metal Products

	Freight Volume[1] (millions of short tons)	Freight Revenue[1] (millions of dollars)	Average Load per Car[2] (short tons)	Average Haul[2] (miles)	Average Revenue[2] (cents per ton-mile)
Aluminum					
Ores	7.2	60	86.4	439	1.51
Primary smelter products	3.8	84	99.6	1130	2.02
Basic Shapes	1.8	50	50.7	988	2.80
Castings	0.1	2	****	****	****
Chromium Ores	0.4	4	****	****	****
Copper					
Ores	10.8	28	97.3	98	1.18
Primary smelter products	2.2	43	****	****	****
Basic shapes (copper, brass & bronze)	0.8	18	****	****	****
Castings (copper, brass & bronze)	**	***	****	****	****
Gold and Silver Ores	**	***	****	[illegible]	****
Iron					
Ores	93.4	363	77.6	148	1.80
Pig iron	3.7	22	83.5	150	3.12
Slag	2.1	5			
Miscellaneous coke-oven products	1.0	6			
Steel ingots and semi-finished shapes	15.9	115	58.4	509	3.03
Other primary iron & steel products	44.3	508	77.8	280	2.50
Ferro-alloys	1.0	18	****	****	****
Wire, nails and spikes	0.5	11	58.0	366	3.40
Castings	3.0	38	****	****	****
Forgings	0.4	7	****	****	****
Scrap and tailings	33.7	266	85.5	193	3.62
Lead					
Lead Ores	0.8	7	84.6*	523*	1.62*
Lead and zinc ores, combined	**	1			
Primary smelter products	1.1	19	****	****	****
Manganese Ores	1.0	10	****	****	****
Tungsten Ores	**	***	****	****	****
Zinc					
Ores	1.7	15	84.6*	523*	1.62*
Primary smelter products	1.2	20	****	****	****
Other Metal Ores	2.0	17	93.5	312	1.90
Other Primary Metal Products					
Nonferrous wire	0.5	17	****	****	****
Nonferrous forgings	**	***	****	****	****
Other products	8.5	48	****	****	****
Other Metal Scrap and Tailings	2.1	44	42.2	589	2.93

*Average values for all shipments of lead and zinc ores.
**Less than 50,000 tons.
***Less than $500,000
****Not available.

Sources:

1. Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics: Class I Railroads, 1974, Washington, D.C., 1976. Data is for shipments terminated by railroads having average annual revenues of $5 million or more.
2. U.S. Department of Transportation, Federal Railroad Administration, 1974 Carload Waybill Statistics, Washington, D.C., December 1975. Data is based on a sample of shipments terminated by railroads having average annual revenues of $3 million or more.

3.0 HIGHWAY TRANSPORT

Of the various modes of freight transport, truck transport is the most versatile and, except for air transport, the fastest. Trucks are better suited than other modes for transporting small (less-than-carload) shipments and, except when very heavy volumes are involved, for providing short-distance service. Establishing road service to new mines and processing locations can be accomplished even when there is no expectation of the high traffic volumes that would be required to justify construction of a rail or pipeline, and, where the terrain is rugged, road access is almost always more practical than rail access. Finally, because transport times are shorter than for other modes covered in this study, truck transport offers advantages for shippers of high value commodities. In those cases inventory savings obtained by prompt and reasonably reliable delivery times more than compensate for higher transport costs.

Truck transport of non-energy minerals may be used for direct service from origin to destination or in conjunction with a rail or water haul. Direct truck service is generally used only for movements which involve a relatively high-valued commodity and/or a small (less-than-carload) shipment, or which require only a relatively short haul. This last category is of particular interest when one is concerned with the economic importance of truck transport to the minerals industry. In the case of minerals which are shipped in very heavy volumes on a relatively permanent basis from one origin to one destination (as with movements from concentrator to smelter) trucks may not be competitive for hauls which exceed 30 to 50 miles. However, when volumes are less heavy, when origins (e.g., within a mine) change periodically, or when destinations change periodically (as with sand and gravel, crushed stone, and cement) or are not served directly by rail, trucks may be the dominant mode for movements of up to 150 miles. When trucks designed for use on public highways are used for a portion of a haul (as when the location being mined is constantly changing), there is an increased probability that these trucks will be used for the entire haul, thus avoiding the cost of transloading to another vehicle.

As commodity value increases or shipment size decreases, trucks become competitive for longer hauls. In the case of smelter products, for example, trucks are used for hauls of up to 400 or 500 miles. Some long-distance shipments which would otherwise be made by rail are obtained by motor carriers at low "backhaul" rates so as to provide loads on return trip~.

Trucks are used for rail access from mines which do not have direct rail service either because of the lack of volume from one or more fixed loading points or because of topographical problems. Trucks are also used to provide access to or from waterways; in this role they compete with railroads in the same way as in the case for direct hauls having similar characteristics.

Truck is the dominant mode for transporting sand and gravel, crushed stone, and cement, as well as for the many minerals which are normally shipped in less-than-carload quantities.

The remainder of this chapter contains sections on trucking-industry structure, technology, and three trucking industry issues which could affect the cost of motor carriage to the minerals industry: weight limits, regulatory reform, and highway financing.

3.1 Industry Structure

Trucking companies which operate in more than one state are regulated by the ICC, while those that operate only in a single state are regulated, in all states but New Jersey and New Hampshire, by state agencies. From a regulatory standpoint, there are five categories of interstate trucking operation:

- Common carriers of general commodities have ICC authority to carry all commodities. They may be either "regular-route carriers" (i.e., they are authorized only to operate over specified routes) or "irregular-route carriers" (i.e., they are authorized only to serve a specific set of points); irregular-route carriers with "radial" authority are further restricted in that all service must be to or from a specified base point. Common carriers of general commodities provide both truckload and less-than-truckload service; but they are particularly important in the latter role, carrying an estimated 86 percent of all intercity shipments of less than 10,000 pounds carried by any mode.

- Common carriers of specific commodities have ICC authority to carry only specific commodities (which may or may not require specialized equipment). These carriers are almost always irregular-route carriers. Except for refrigerated, household-goods and package-freight carriers, these carriers primarily provide direct point-to-point truckload service. The seventeen specific-commodity categories includes dump-trucking (of sand, gravel, coal, etc.), and mine ores and smelter products.

- Contract carriers have ICC permits to carry specific commodities under contract to a limited number of firms. Minerals and mineral products which are frequently hauled by these carriers include sand and gravel, building materials, iron and steel, and other metals.

- Exempt carriers need no ICC certificate but are limited to carrying exempt agricultural commodities.

- Private carriers are firms which are not primarily engaged in transportation. They need no ICC certificate but are limited to transporting their own goods within the scope of their business.

In addition to the above categories of trucking operation, there is the independent trucker or "owner/operator". This is a truck-owner who does not possess ICC operating authority but operates his own truck in intercity service by hauling exempt commodities and/or by leasing his services to a carrier which does. Union opposition has tended to restrict the use by trucking companies of owner/operators to commodities which are normally hauled in truckload shipments, and they are most frequently used for hauling commodities for which rail competition is keenest.

Charles River Associates (CRA) has estimated that there are about 100,000 owner/operators and that they account for about 26 percent of all intercity ton-miles.[1] Slightly more than half of their contribution is in the hauling of exempt commodities, while most of the rest consists of contract services to specific-commodity carriers and to contract carriers. An estimated 31 percent of mileage by building-materials carriers is performed by owner/operators.[1]

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[1] Charles River Associates, Inc., Potential Fuel Conservation Measures by Motor Carriers in the Intercity Freight Market, prepared for Federal Energy Administration, Washington, D.C., March 1977, Volume II, Table A-12.

Truckload movements of minerals are generally handled by specific-commodity or contract carriers or privately by the mining companies themselves. Private trucking has the advantage of permitting complete integration of mining and transport operations. On the other hand, commercial carriers can frequently provide more economical service as a result of better vehicle utilization, both because vehicles can be used to serve other customers if the mining company has a slack period and because backhauls can be obtained from other customers to reduce empty mileage. These movements are usually made under commodity rates which are adjusted by the carriers to reflect operating costs, level of service required by the shipper, and competition from railroads and other motor carriers.

Contract carriers used for minerals transport range in size from those operating a single truck to those with fifty or more vehicles. Specific-commodity common carriers are usually large, with some operating more than one thousand tractors and two thousand trailers.

Although a choice of carriers is usually available, ICC entry restrictions tend to limit the extent of that choice for interstate movements, particularly for shipping volumes which do not warrant either contract service or an application for a new irregular-route authorization. State regulators, however, are usually less restrictive, at least in the case of minerals, and so greater competition may exist for intrastate movements. Many shippers prefer to split their business among available carriers so as to foster competition.

For high-volume short-distance movements, such as hauls from mine to railhead and shipments of construction aggregate, backhauls are not likely to be available, and hence private carriage is quite common (sometimes supplemented by commercial carriage during peak periods). However, in recent years, some mining companies have moved out of private carriage so as to concentrate on their primary line of business and minimize the number of unions and regulatory agencies with which they must deal. This trend is generally limited to movements in those trucking markets in which adequate competition exists.

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[1] D. Daryl Wyckoff and David H. Maister, The Owner-Operator: Independent Trucker, D.C. Heath and Co., Lexington, Mass., 1975, p. 18.

Minerals which are shipped in less-than-truckload quantities are generally handled by common carriers of general commodities. These movements are shipped under class rates which are somewhat insulated from competition, do not always reflect costs, and provide only limited opportunities for shippers to obtain lower rates in return for a reduced level of service.

Tables 3.1 and 3.2 present 1973 data on traffic volumes of non-energy minerals and selected mineral products carried by Class I motor carriers. This data is only for the 956 motor carriers with average annual operating revenues over $1 million.[1] It can be seen from the tables that these large carriers are a more significant factor in the carriage of mineral products than in the carriage of minerals themselves.

The minor role that these carriers play in transporting ores, concentrates and most nonmetallic minerals is especially evident in the case of crushed stone. One point zero six (1.06) billion tons were shipped in 1973,[2] of which 85 percent or more was transported by truck. Yet only about 700,000 tons were transported by Class I carriers. Most crushed stone is transported by private or contract carriers.

Table 3.1: Class I Motor-Carrier Data for Metals and Primary Metal Products

	Freight Volume (thousands of short tons)	Freight Charges (millions of dollars)
Aluminum		
Ores	22	0.8
Primary smelter products	495	11.7
Basic shapes	1855	54.7
Castings	285	7.1
Chromium Ores	4	0.1
Copper		
Ores	9	0.1
Primary smelter products	188	3.9
Basic shapes (copper, brass & bronze)	948	26.5
Castings (copper, brass & bronze)	127	4.0
Gold and Silver Ores	1	*
Iron		
Ores	23	0.4
Pig iron	593	10.3
Miscellaneous coke-oven products	2100	25.4
Steel ingots and semi-finished shapes	2636	35.1
Other primary iron & steel products	16788	244.7
Ferro-alloys	300	4.5
Wire, nails and spikes	1896	36.6
Castings	4449	83.6
Forgings	1283	19.6
Scrap and tailings	191	2.5
Lead		
Lead ores	13	0.2
Lead and zinc ores, combined	5	0.1
Primary lead-based smelter products	159	2.9
Manganese Ores	240	1.1
Tungsten Ores	4	0.1
Zinc		
Ores	100	0.7
Primary smelter products	175	3.0
Other Metal Ores	790	5.7
Other Primary Metal Products		
Nonferrous wire	966	31.3
Nonferrous forgings	89	2.7
Other products	2691	53.3
Other Metal Scrap and Tailings	475	9.1

*Less than $50,000.

Source: Interstate Commerce Commission, Bureau of Accounts, Freight Commodity Statistics: Motor Carriers of Property, 1973, Washington, D.C., 1976. Data is for shipments terminated by motor carriers having average annual revenues of $1 million or more.

B2. Copper Movements

As noted in the preceding section, copper is shipped from mine to smelter, from smelter to refinery, and from the refineries to brass mills, wire mills and other consumers. The firms that are both geographically and structurally integrated ship refined copper from the mine site, whereas other firms ship concentrates and unrefined copper as well as refined copper. This section describes the movements from mine to market beginning with copper concentrates and precipitates.

Before discussing copper movements it will be helpful to discuss the products that are actually shipped. Copper mines produce a crude ore which is usually transported by truck to an on-site or nearby mill where the ore is reduced to copper concentrates and precipitate. The transport of crude ore between mine and mill is normally considered to be part of the mining operation. Therefore, the first products of interest in terms of transport are copper concentrates, which average about 26 percent copper content, and copper precipitate (sometimes referred to as cement copper) which normally contains between 50 to 60 percent copper, but which may contain as much as 90 percent copper. With the trend towards increased leaching of waste dumps, copper precipitate is becoming an increasingly important form of copper. Its shipping and handling characteristics are similar to that of concentrate, so shipping procedures should not be affected except in special cases. For this reason, copper precipitate movements are not discussed separately.

The increase in leaching copper ores has led to another technological development - electrowinning of copper directly from the leach solution. The product of this process is copper cathode. The general effect of electrowon copper production on shipping is two-fold: the total tonnage of material moved per pound of copper is reduced; and shipments of this product are made directly from mine to refinery.

Copper smelters produce blister copper and anode copper, both of which are shipped directly to the refineries. Since not all of the companies own smelters there is a considerable amount of toll smelting of concentrates by the companies owning smelters. Four companies, Asarco, Inspiration, Magma, and Phelps Dodge do most of the toll smelting.

The refineries produce copper cathodes, wire bars, copper cake, billets and continuous cast wire rod. They may also produce chemicals such as copper sulfate. Much of the copper produced by the nonintegrated producers is refined on a toll basis.

Figure B. 4 depicts interstate movements of copper concentrate (and precipitate). The magnitude of interstate shipments has been bracketed in two categories: 0 to 100,000 tons, and 100,001 to 300,000 tons.[1] These ranges were defined so as to avoid disclosure of individual company shipments. Arizona and New Mexico have been combined into a single origin for the same reason.

Copper-concentrate shipments are confined primarily to the western states and reflect both intra-firm and inter-firm shipments. Most interstate shipments originate in Nevada and Arizona, with a fairly substanial quantity of material moving north to Washington and Montana. Another substantial movement of material takes place between Arizona/New Mexico and Texas.

There are intra-state movements of concentrate in Arizona, New Mexico, and Montana. Most of these shipments are over relatively short distances.

Copper-concentrate shipments vary from year to year as well as quarterly. Variations are caused by smelter availability as well as changes in mine production. Overall, the ranges provide a reasonable representation of relative magnitudes.

Smelter availability to non-integrated producers during peak production periods affects copper-concentrate movements. During these periods concentrates may even move cross-country to smelters that do not normally toll smelt concentrates. Also, concentrates are sometimes imported during peak periods, so that peak-period shipping patterns may differ from the major movements depicted in Figure B. 4.

Figure B. 5 shows the most important interstate movements of blister, anode, electrowon copper, and copper crystals. These products are similar in quality and, as a group, will be referred to as unrefined copper. As can be seen, unrefined copper movements differ considerably from concentrate movements. Most unrefined copper moves from west to east and tonnages shipped are generally greater than those of concentrates. Again, movements have been assigned a tonnage range so that relative magnitudes can be assessed.

The largest movement is from Arizona/New Mexico to Texas and reflects a recent change in refinery location. Asarco has now completed construction of a new refinery at Amarillo that replaces its two east coast refineries which were old and costly to operate and have since been closed. Copper that formerly was shipped to Asarco's east coast refineries now goes to Texas.

Unrefined-copper movements are generally more stable than concentrate shipments, though there may be minor changes in the pattern during peak periods in the industrial cycle.

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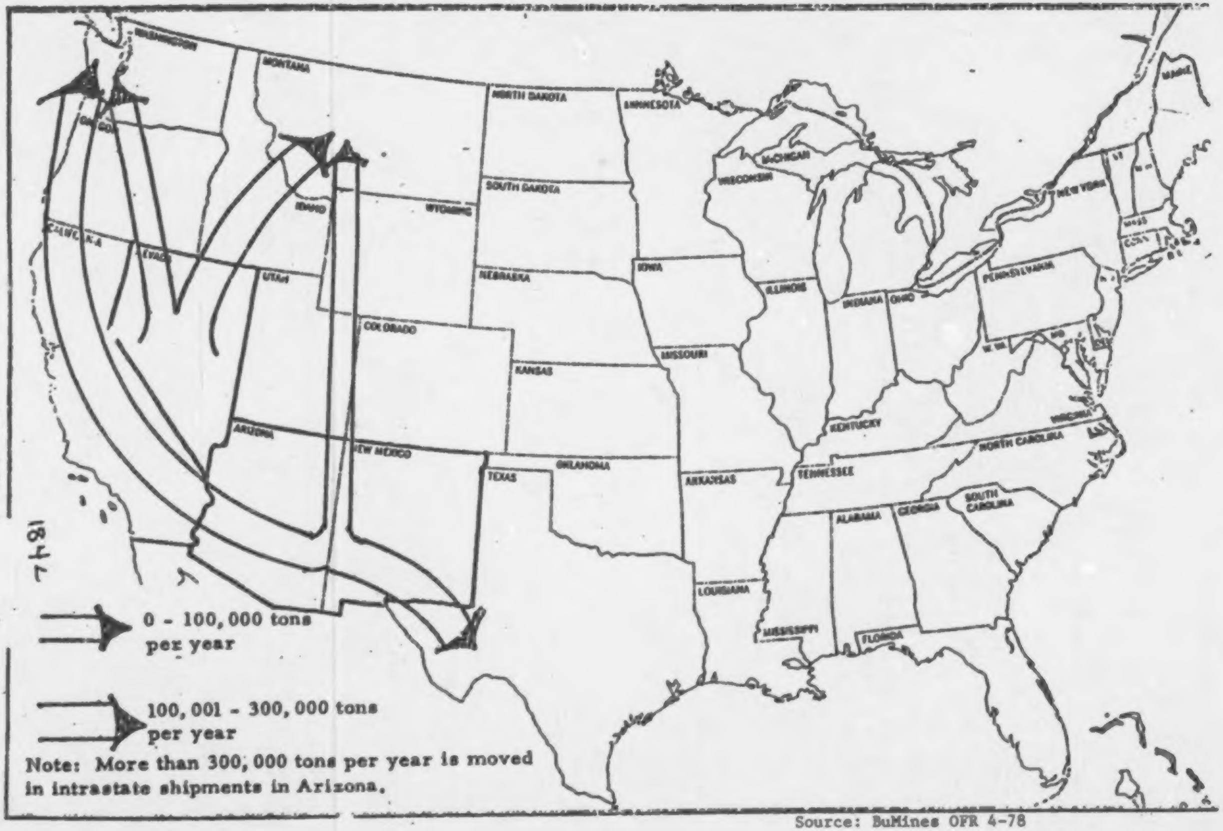
[1] All volume data represents tons of commodity shipped, not tons of copper content (as is usually the case for copper-industry data.)

FIGURE B.4: INTERSTATE MOVEMENTS OF COPPER CONCENTRATES


WASHINGTON
MONTANA
OREGON
IDAHO
WYOMING
CALIFORNIA
NEVADA
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W. VA.
MD
PENNSYLVANIA
NEW YORK
VT
N.H.
MASS
CONN
R.I.
MAINE
0 - 100,000 tons per year
100,001 - 300,000 tons per year

Note: More than 300,000 tons per year is moved in intrastate shipments in Arizona.

1842

Source: BuMines OFR 4-78

B4.1 Copper Concentrate

B4.1.1 Rail

Both hopper cars and open gondolas are used to move copper concentrates by rail. Copper precipitates are often moved in open gondolas. One-hundred-ton hopper cars are most commonly used for concentrate, although the type of car used actually depends on the unloading facilities at the smelter that receives the concentrate. Three types of hopper cars are used: (1) air dump, (2) bottom dump, and (3) side dump. The gondolas have solid bottoms.

The two types of hopper cars used most commonly are bottom-dump hopper cars and air-dump hopper cars. A car that is used to a lesser extent is the open-to-side, side-dump car. Although some 70-ton cars are used, 100-ton cars are used whenever possible.

The air-dump hopper car was specially designed by Asarco for copper-concentrate movements. The principle advantage of the air-dump hopper car is the speed with which it can be unloaded. More rapid unloading reduces car requirements because the cycle time from mine to smelter and return is decreased. It also reduces unloading cost which is substantial for the tonnages of material involved. The Asarco smelters, Magma Copper Co.'s smelter at San Manuel, and the Inspiration smelter all prefer the air-dump cars.

The Southern Pacific Railroad arranges for construction and owns the air-dump cars. They are apparently more expensive than standard bottom-dump cars. They are also more easily damaged in the unloading process. As a result, if the cars are damaged at a smelter, the railroad becomes reluctant to permit further use by the offending smelter until the problem is corrected.

Loading technology is straightforward. Both front-end loaders and elevators are used. The cars are normally filled as rapidly as the concentrate is produced at the concentrator. The larger mines try to move the cars out as soon as they are filled. In practice, this means that they try to ship at least once a day.

One company, Anaconda, at Butte, Montana, uses tank cars as a method for moving copper concentrate as a slurry. Shipping as a slurry in tank cars simplifies handling procedures and is cheaper than drying the concentrate and then shipping it in gondola or hopper cars. A pipeline was apparently not considered to be feasible because of slurry flow problems induced by sub-freezing winter temperatures.

Another company, Inspiration, has devised a novel and efficient method for delivering high-purity copper precipitate to their customers as a slurry in box cars. They have worked out an arrangement with the Southern Pacific Railroad that permits them to use several box cars exclusively for precipitate movements. This arrangement is important because the cars are specially lined to prevent slurry loss in transit. The lining also minimizes moisture loss so that the precipitate does not dry and harden in transit, a condition that results in severe unloading problems. Significant cost reductions are realized by eliminating the need for special car preparation prior to each shipment.

B4.1.2 Motor Carrier

Road movement from mine to rail head is effected through the use of trucks. Both bottom-dump and rear-dump solid-bottom semi-trailers are used. Normal load is 20-22 tons of copper concentrate or precipitate. Rail cars are normally loaded either by conveyor, front-end loader, or by dumping directly from a loading ramp into the rail cars.

The truck-rail movements are generally smaller volume moves so that transit times become more important. This is especially true for copper precipitate movements. For example, one company found that, because a very indirect routing was required, rail movements to the smelter for their precipitates were taking several days and also that significant differences between shipped weight and weight received at the smelter were occurring. They began to use truck haulage and achieved 24-hour delivery with insignificant weight loss. The increased delivery speed accompanied by the reduced weight loss more than paid for the increased cost of truck haulage.

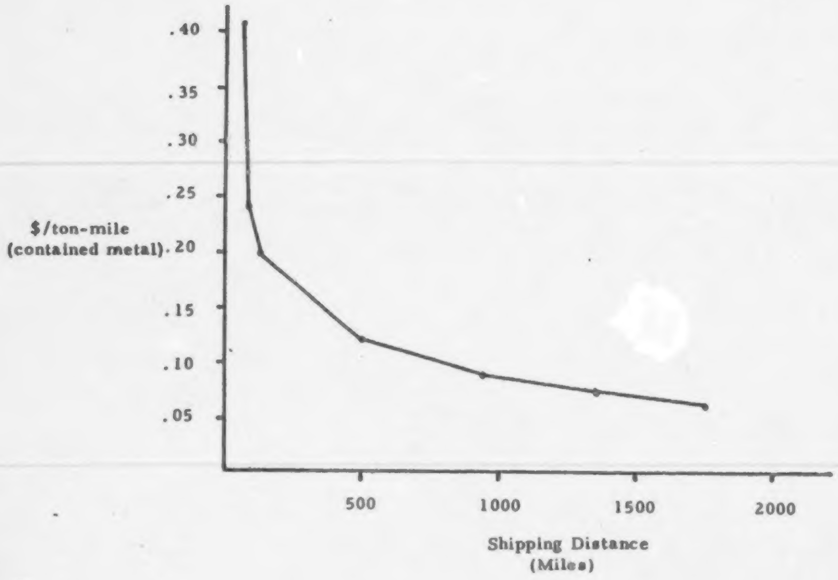
B5. Transport Rates for Copper Products

Transport rates for moving copper products depend on a number of factors including the type of product, the shipping volume, the region or origin, the extent of competition, and the length of haul. Rates for transporting these commodities were readily obtained from shippers and carriers. Shippers tended to cite actual rates for point-to-point, multi-car or minimum annual volume movements, while carriers supplied the higher single-car commodity and class rates. Trucking rates applicable to these products were more difficult to obtain because these are generally set on a contract basis. However, some data was compiled to make a comparison with rail rates. The following sections summarize the findings relating to transport rates applicable to copper products.

B5.1 Rates for Moving Copper Concentrates

Copper concentrates are generally transported in large volumes by rail carriers from western mills to western smelter plants. Figure B.7 illustrates the relationship between the rail rates and the shipping distance associated with these movements. There are definite economies realized in longer distance movements, with a 100-mile movement costing 22.5 cents per ton-mile, a 500-mile movment costing 12.0 cents per ton-mile, and a 1,000-mile movement costing 8.8 cents per ton-mile. These rates pertain to the contained copper metal, and are consequently considerably higher than rates for equivalent shipments of refined copper products. The actual gross rates for transporting copper concentrates can be derived by multiplying the rates shown in Figure B.7 by 0.26, since concentrates generally contain about 26 percent copper. Thus, the rate for a 100-mile movement of copper concentrates is about 5.9 cent per ton-mile and for a 500-mile movement is about 3.1 cents per ton-mile, well below the rate levels applicable to higher value copper products.

FIGURE B.7: RAIL RATE SCALE AT EX-PARTE 336 LEVEL BY SHIPPING DISTANCE FOR SHIPPING COPPER CONCENTRATES



Source: BuMines OFR 4-78 p. 208

IV. A. Significance of Mining to State Economies

The significance of the nonfuel mining and mineral processing industries to State economies can be measured in several ways: (1) Output effect measures the value of materials produced by these industries. (2) Employment effect shows the number of jobs generated by these particular economic activities, and (3) Income effect calculates the total annual income based on personal wages and salaries earned by workers in these particular industries. Each effect can be derived on a direct, an indirect, or an induced basis, or a combination of two or three.

A direct value or employment level refers only to economic activity in the principal producing industry or industries. An indirect value or employment level refers to economic activity created by sales of goods and services by second, third, fourth and fifth-level suppliers to the principal producing industry. An induced income value or employment level identifies the changes in income and changes in employment in the economy resulting from the increased consumer spending of income earned by workers producing the direct and indirect output of the mineral industry.

The percentages of direct output, indirect output effect and induced income effect as compared with the respective gross State product will give some indication of the significance of the nonfuel mining and processed materials industry, as defined. Furthermore, the significance of mining industry employment can be demonstrated by comparing it with the average annual statewide non-agricultural employment of the State.

The year 1979 was chosen because it was the latest year that data are readily available and 1977 was chosen because it was the latest year that a comprehensive census was conducted for both the mineral industries and the manufacturing industries. Many company confidential and data disclosure problems made it necessary to use judgmental estimates to fill in data gaps. There were no readily available data on gross State product. The gross State products were estimated principally from regional State income data from the Department of Commerce with supplemental data from the respective States. It should be noted that this data exclude the impacts of uranium and fossil fuel mining activities in these States.

The output multiplier for the mineral industries measures the ratio of the sum of direct and indirect purchases from all economic sectors needed to deliver one additional dollar of output from the mining industry to consumer demand to direct output within a given year. Generally, the State output multipliers of the mining industries range from 1.2 to 1.5, whereas the State output multipliers of the mineral processing industry range from 1.5 to 2. The total income and employment multipliers are generally higher than total output multipliers. Total income or employment multipliers are calculated from the ratio of the direct, indirect and induced effect to direct change of effect when demand increases.

The value of direct output of the mineral industry in Arizona (table IV A-1) was about 9 percent of the estimated gross State product during 1977-79, whereas the percentage of the value of direct output of the basic mineral processing industry-i.e., Standard Industrial Classification (SIC) 32 and 33 - was also about 9 percent. The U.S. totals were 1 percent and 9 percent, respectively. But the indirect output effect of the mineral processing industry is about double that of mining. The total output effect of both industries constituted about one-third of the Arizona gross

State product. The mineral industry is critical to the economy of Arizona. The large primary copper industry and the nonferrous rolling and drawing industry with their large output multipliers were responsible for this predominancy. The induced income effect will add another 3 percent to the roughly 36 percent of the total gross State product. Similarly, the total employment effect is also relatively important in the State. Starting with a direct employment effect of mineral and related industries of about 4 percent of the statewide nonagricultural workers, the total employment effect accounts for about 14 percent of the State total nonfarm employment during the period.

The direct output value of the mineral industry in California (table IV A-2) was represented by only a low 0.6 percent of the gross State product, whereas the mineral processing industry accounted for about 3.7 percent. The total output effect for both industries accounted for just 6.6 percent of the gross State product. With the addition of the induced income effect, the whole mineral industry in California was responsible for only about 7.5 percent of the gross State product. The total direct, indirect, and induced employment of the mineral industry accounted for only about 4.6 percent of the statewide nonagricultural workers.

The direct output value of the mining industry in Colorado (table IV A-3) was about 2.4 percent of the gross State product, whereas the mineral processing industry (SIC 32 and 33) accounted for another 3.4 percent. But the total output effect of the mineral industries is slightly over 10 percent of the gross State product. The induced income effect added 1 percent for a total of 11 percent. The total employment effect of the mineral industry accounted for about 7.5 percent of the statewide nonfarm workers in Colorado.

The nonfuel mining and mineral processing industry is also important in the Idaho economy. The total employment effect (table IV A-4) accounted for over 30 percent to the total statewide nonagricultural working force, of which nonferrous, principally silver, and phosphate rock mining sectors comprise nearly 20 percent. The total output effect plus the induced income effect of the mineral and related industries was responsible for about 10 to 11 percent of the gross State product. Silver mining has been the pillar of Idaho's mineral economy since the closing of the Bunker Hill lead-zinc-silver refining complex. The Idaho Division of Financial Management estimates that as many as 4,600 local jobs may be lost as a result of the closure, and that $80 million in wages and $9 million in tax receipts may be lost by the end of 1982.

Since 1978, both the concrete and gypsum product industry and the nonferrous rolling and drawing industry have overtaken the copper mining industry in Nevada (table IV A-5) to become the number 1 and number 2 mineral industries, respectively. The decline of the copper-related mining industry was responsible for the decline of the mineral industry as a whole and also hurt the State nonservice economy. The percentage of total output effects i.e., direct and indirect of the gross State product decreased from 10 in 1977 to nearly 8 in 1979. The total employment effect accounts for about 6 percent of the State nonfarm population.

The copper mining, smelting, and refining industry and the potash mining industry are responsible for the bulk of the mineral industry in New Mexico (table IV A-6). The total output effect of the mineral industry accounts for over 20 percent of the gross State product. The total employment effect accounts for over 9 percent of the State's nonfarm employment.

The direct output of metal mining and processing, principally copper mining, smelting, and refining, including steelmaking accounts for over 9 percent of the gross State product in Utah (table IV A-7). The total output effect of the mining and mineral processing industry is directly and indirectly responsible for over 20 percent of the gross State product. The induced income effect adds another 5 percent to this total. The total employment effect of the mineral and related industry accounts for about 22 percent of the nonfarm workers in Utah. Like Arizona, and to a certain extent New Mexico, Utah is heavily dependent on its metal mining and primary metals industries.

TABLE: IV A 1

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Minerals Origin on the State of Arizona for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effect, millions of current dollars:			
1977:			
Direct	1,555	1,752	3,337
Total (direct and indirect)	2,178	4,085	6,263
1978:			
Direct	1,805	2,061	3,866
Total (direct and indirect)	2,518	4,598	7,116
1979:			
Direct	2,491	2,465	4,956
Total (direct and indirect)	3,529	5,440	8,969
Employment effect, numbers/ 1,000 jobs:			
1977:			
Direct	21.0	12.0	33.0
Direct and indirect	34.0	33.7	67.7
Direct, indirect, and induced	70.5	60.7	131.2
1978:			
Direct	18.9	14.0	32.9
Direct and indirect	30.6	36.4	67.0
Direct, indirect, and induced	63.5	65.3	128.8
1979:			
Direct	21.3	15.6	36.9
Direct and indirect	34.5	40.6	75.1
Direct, indirect, and induced	71.6	62.8	134.4
Income effect, millions of current dollars:			
1977:			
Direct	321.6	185.0	506.6
Direct and indirect	449.3	738.3	1,187.6
Direct, indirect, and induced	672.0	1,107.4	1,779.4
1978:			
Direct	310.7	230.1	540.8
Direct and indirect	434.0	871.8	1,305.8
Direct, indirect, and induced	650.0	1,305.7	1,955.7
1979:			
Direct	386.9	280.0	666.9
Direct and indirect	540.5	1,072.4	1,612.9
Direct, indirect, and induced	809.5	1,606.1	2,415.6

1/ Nonfuel minerals include SIC 10 except uranium ores and SIC 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origins include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A 2

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Minerals Origin on the State of California. for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effect millions of current dollars:			
1977:			
Direct	1,339.9	6,853.6	8,193.5
Direct and indirect	2,085.5	12,359.8	14,445.3
1978:			
Direct	1,511.7	7,879.5	9,391.2
Direct and indirect	2,370.2	14,173.8	16,544.0
1979:			
Direct	1,769.7	8,290.3	10,060.0
Direct and indirect	2,773.2	14,900.5	17,673.7
Employment effect, numbers/ 1,000 jobs:			
1977:			
Direct	12.7	104.8	117.5
Direct and indirect	26.9	181.1	208.0
Direct, indirect, and induced	54.7	357.7	412.4
1978:			
Direct	13.1	111.1	124.2
Direct and indirect	24.2	191.8	216.0
Direct, indirect, and induced	56.7	367.3	424.0
1979:			
Direct	13.5	117.9	131.4
Direct and indirect	24.9	203.1	228.0
Direct, indirect, and induced	58.4	388.8	447.2
Income effect, million of current dollars:			
1977:			
Direct	235.5	1,425.6	1,661.1
Direct and indirect	343.3	2,700.6	3,043.9
Direct, indirect, and induced	573.2	4,509.2	5,082.4
1978:			
Direct	265.7	1,510.0	1,875.7
Direct and indirect	388.6	3,037.4	3,425.9
Direct, indirect and induced	647.2	5,071.4	5,718.6
1979:			
Direct	288.3	1,842.2	2,130.5
Direct and indirect	422.2	3,476.1	3,898.3
Direct, indirect, and induced	702.4	5,806.0	6,508.4

1/ Nonfuel minerals include SIC 10 except uranium ores and SIC 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A 3

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Mineral Origin on the state of Colorado for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effect millions of current dollars:			
1977:			
Direct	537.5	881.4	1,418.9
Direct and indirect	832.4	1,610.0	2,442.4
1978:			
Direct	641.8	989.1	1,630.9
Direct and indirect	996.9	1,807.9	2,804.8
1979:			
Direct	826.1	1,093.5	1,919.6
Direct and indirect	1,288.2	1,995.7	3,283.3
Employment effects numbers/ 1,000 jobs			
1977:			
Direct	10.3	13.9	24.2
Direct and indirect	15.7	30.0	45.7
Direct, indirect, and induced	26.3	52.2	78.5
1978:			
Direct	10.9	15.4	26.3
Direct and indirect	16.9	33.2	50.1
Direct, indirect, and induced	28.3	57.8	86.1
1979:			
Direct	12.0	16.9	28.9
Direct and indirect	18.5	36.6	55.1
Direct, indirect, and induced	31.1	63.7	94.8
Income effect millions of current dollars:			
1977:			
Direct	165.2	209.5	374.7
Direct and indirect	234.9	420.3	655.2
Direct, indirect, and induced	345.1	617.5	962.6
1978:			
Direct	178.6	239.6	418.2
Direct and indirect	255.2	477.6	732.8
Direct, indirect, and induced	375.2	699.8	1,075.0
1979:			
Direct	211.3	282.1	493.4
Direct and indirect	301.9	561.4	863.3
Direct, indirect, and induced	443.8	825.5	1,269.3

1/ Nonfuel minerals include sic 10 except uranium ores and sic 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A -4

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Mineral Origin on the State of Idaho for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effects millions of current dollars:			
1977:			
Direct	252.7	160.7	413.4
Direct and indirect	350.2	268.7	618.9
1978:			
Direct	299.2	172.8	472.0
Direct and indirect	414.2	291.1	705.3
1979:			
Direct	437.9	191.9	639.8
Direct and indirect	604.2	314.0	918.2
Employment effect numbers/ 1,000 jobs:			
1977:			
Direct	3.5	2.4	5.9
Direct and indirect	5.2	5.0	10.2
Direct, indirect, and induced	8.9	7.8	16.3
1978:			
Direct	4.0	2.7	6.7
Direct and indirect	6.1	5.9	12.0
Direct, indirect, and induced	10.3	9.1	19.4
1979:			
Direct	4.4	2.8	7.2
Direct and indirect	6.7	6.3	13.0
Direct, indirect, and induced	11.2	9.8	21.0
Income effect millions of current dollars.			
1977:			
Direct	53.1	32.8	85.9
Direct and indirect	70.2	70.1	140.3
Direct, indirect, and induced	97.0	96.8	193.8
1978:			
Direct	60.5	34.2	94.7
Direct and indirect	90.2	76.0	166.2
Direct, indirect, and induced	110.6	104.9	215.5
1979:			
Direct	68.7	49.3	117.0
Direct and indirect	91.1	91.6	182.7
Direct, indirect, and induced	125.7	126.4	252.1

1/ Nonfuel minerals include sic 10 except uranium ores and sic 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A 5

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Mineral Origin on the State of Nevada for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effects, millions of current dollars:			
1977:			
Direct	263.8	208.8	472.6
Direct and Indirect	349.9	315.6	665.5
1978:			
Direct	237.4	238.2	475.6
Direct and Indirect	314.3	360.1	674.4
1979:			
Direct	238.1	290.3	528.4
Direct and Indirect	313.5	438.7	752.2
Employment effect numbers/ 1,000 jobs:			
1977:			
Direct	4.1	2.7	6.8
Direct and indirect	6.8	3.5	9.3
Direct, indirect, and induced	12.7	6.8	19.5
1978:			
Direct	4.2	3.0	7.2
Direct and indirect	7.2	4.0	11.2
Direct, indirect, and induced	13.9	7.8	21.7
1979:			
Direct	4.7	3.4	8.1
Direct and indirect	8.2	4.7	12.9
Direct, indirect, and induced	16.0	8.9	24.9
Income effects millions of current dollars:			
1977:			
Direct	65.0	41.1	106.1
Direct and indirect	83.3	70.8	154.1
Direct, indirect, and induced	111.9	95.1	206.0
1978:			
Direct	69.5	52.4	121.9
Direct and indirect	93.0	90.4	183.4
Direct, indirect, and induced	119.7	121.5	241.2
1979:			
Direct	86.8	64.8	151.6
Direct and indirect	111.0	112.0	223.0
Direct, indirect, and induced	149.2	152.5	301.7

1/ Nonfuel mineral include sic 10 except uranium ores and sic 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A 6

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Mineral Origin on the State of New Mexico for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effects, millions of current dollars:			
1977:			
Direct	497.0	389.9	886.9
Direct and indirect	738.8	945.5	1,684.3
1978			
Direct	477.6	464.3	941.9
Direct and indirect	709.5	1,118.2	1,827.9
1979:			
Direct	694.5	589.1	1,283.6
Direct and indirect	1,037.1	1,426.0	2,463.1
Employment effect, numbers/ 1,000 jobs:			
1977:			
Direct	7.2	3.1	10.3
Direct and indirect	11.8	8.7	20.5
Direct, indirect, and induced	24.5	15.4	39.9
1978:			
Direct	7.4	3.2	10.6
Direct and indirect	12.2	9.0	21.2
Direct, indirect, and induced	24.9	16.0	40.9
1979:			
Direct	8.2	3.5	11.7
Direct and indirect	13.5	10.5	23.7
Direct, indirect, and induced	27.7	18.2	45.3
Income effect, millions of current dollars:			
1977:			
Direct	108.6	37.8	146.4
Direct and indirect	151.3	185.1	336.4
Direct, indirect, and induced	214.2	262.3	476.5
1978:			
Direct	122.9	47.7	170.6
Direct and indirect	171.2	222.3	393.5
Direct, indirect, and induced	242.4	314.9	557.3
1979:			
Direct	156.3	58.9	205.2
Direct and indirect	217.4	281.9	499.3
Direct, indirect, and induced	308.2	408.3	716.5

1/ Nonfuel minerals include sic 10 except uranium ores and sic 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

TABLE: IV A 7

Effect of Production of Nonfuel Minerals and Processed Materials of Nonfuel Mineral Origin on the State of Utah for 1977, 1978, and 1979

	Nonfuel minerals 1/	Processed materials of nonfuel mineral origins 2/	Total
Output effect, millions of current dollars			
1977:			
Direct	497.2	772.3	1,269.5
Direct and indirect	788.0	1,854.3	2,642.3
1978:			
Direct	552.6	900.3	1,452.9
Direct and indirect	874.8	2,134.3	3,009.7
1979:			
Direct	753.4	1,022.9	1,776.3
Direct and indirect	1,194.6	2,422.2	3,616.8
Employment effect, Number/ 1,000 jobs:			
1977:			
Direct	9.5	11.6	21.1
Direct and indirect	13.2	47.6	60.8
Direct, indirect, and induced	22.6	88.4	111.0
1978:			
Direct	10.0	12.2	22.2
Direct and indirect	13.9	49.9	63.8
Direct, indirect, and induced	23.8	92.3	116.1
1979:			
Direct	10.7	12.6	23.3
Direct and indirect	14.9	51.0	65.9
Direct, indirect, and induced	25.5	94.4	119.9
Income effect, millions of current dollars			
1977:			
Direct	153.5	201.7	355.2
Direct and indirect	232.6	1,229.3	1,461.9
Direct, indirect, and induced	345.6	1,836.5	2,182.1
1978:			
Direct	182.6	229.9	412.5
Direct and indirect	276.3	1,355.1	1,631.4
Direct, indirect, and induced	410.8	2,024.6	2,435.4
1979:			
Direct	201.0	256.0	457.0
Direct and indirect	304.0	1,532.3	1,836.3
Direct, indirect, and induced	451.9	2,289.2	2,741.1

1/ Nonfuel minerals include sic 10 except uranium ores and sic 14 plus cement and limes.

2/ Processed materials of nonfuel mineral origin include SIC 32 less cement and lime plus SIC 33.

IV. B. Project Financing Problems

1. Capital Availability

"The importance of the small miner differs depending on the commodity and the location. For example, an unpublished Bureau of Mines report showed that while small miners produced only five percent of the nation's silver in 1975, they accounted for 59 percent of silver production in California, 56 percent in Nevada, and 71 percent in 37 other states. They produced 12 percent of the nation's gold, but 80 percent of California's and 35 percent of New Mexico's". [1]

As with major mineral producers, project financing is a problem for small miners. The problems surrounding project financing are basically the same regardless of the size of the business, but, they are amplified for small miners, who are not able to absorb their impact as larger firms may be able to do. Large firms with sufficient profits are able to take advantage of a number of tax code provisions, such as depreciation, percentage depletion, amortization, and expensing exploration and drilling costs, to enchance their cash flow. The small miner operating at a marginal level is unable to reap the benefits of these tax incentives. Instead his financial statement is apt to show the picture of a no-profit or low-profit operation with little cash flow. In a high-risk industry such as mining, investors are likely to shun such operations.

The structure of funding for major resource developments such as a new mine and related processing facilities is generally known as project financing[2]. Project financing, simply put, is the provision of funds for a specific economic unit where the financing is secured principally by the asset of that unit with repayment derived from the unit's cash flow rather than the earnings of a parent company or group of sponsors. Often, small miners' lack of technical direction and discipline preclude them from having the collateral that would allow them to attract investors to project financing of their mines.

The small miner traditionally has played an important role in the discovery and development of new ore deposits[3]. The ability to fund capital additions depends on the profitability of the business. For large businesses, if profits are inadequate, bond ratings are reduced and debt can be sold only at high rates of interest if at all[4]. The profitability problem is a very real one in today's mineral markets. The minerals industry is faced with sluggish demand and rapidly falling prices. As a result producers are curtailing production and shutting down marginal mining and processing facilities in an effort to minimize losses. Gulf Resources and Chemical Corp. of Houston shut down the Bunker Hill plant at Kellogg, Idaho, which accounted for one-fifth of the U.S. processing of lead, zinc, and silver[5]. The impact of such shutdowns affects small miners too, because they are cut off from nearby custom processing facilities for their mine and mill products.

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[1] "Locatable Minerals Produced in the U.S. in 1975 by State and Proportion Produced by Small Miners," unpublished report of the Bureau of Mines, U.S. Department of the Interior, June 24, 1977.

[2] Mining Magazine. The Role of Banks in Mining Projects. v. 145, No. 4 Oct. 1981, p.p. 285-288.

[3] Work cited in footnote 1.

[4] Mining Congress Journal. Escalating Capital Requirements in the Mining Industry. v. 65, July 1979, p.p. 29-33.

In most instances shares of major mining stock are selling at significant discount from their book value. This is apparent from the premiums being offered by some oil companies for the acquisition of shares of mining companies[6,7]. Consequently, management is reluctant to sell new shares to raise capital because to do so would dilute the value of existing shares. Many small mining companies are closely held family controlled corporations and thus have limited ability to raise capital through equity financing.

Thus, it appears that two of the major sources of funds for investment, equity financing and debt financing, are difficult to obtain in today's financial markets. Retained earnings is the one remaining element that is available as a source of financing the acquisition of capital assets. However, if there is no profit over time, as is the case for many small miners facing high costs and low prices, there can be no retained earnings.

Nevertheless, faced with a shortage of internally generated funds, mining companies must continue to compete for external funds. For at least two decades, the debt-equity ratios for these mineral industries have increased significantly, especially for the primary nonferrous metals industry.

As the costs of developing new projects continue to escalate, the need for "outside" help, particularly for the small miner, grows. The requirement by some for hard data to verify that there are project financing problems in the minerals industry is frustrated by the fact that the data are just not readily available if available at all. The following statements about the lack of data to "prove" that there has been (1) an increase in the capital requirements for new investment, (2) an increase in the cost of capital, and (3) growing concern about the availability of capital, are taken from DeYoung and Yasnowsky[8].

> One major problem is that data presented are in an aggregative form. The conditions indicated by or the implications drawn from aggregative data may not be applicable to specific minerals or companies. The basic data problem is that financial data are generally not available for specific minerals or for nonfuel minerals only. Many companies are engaged in a variety of economic activities. This makes it difficult to obtain information relating solely to mining activities.

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[5]. Business Week. Hard Times Get Worse for the Metals Industry. Dec. 7, 1981, pp. 35-36.

[6]. Work cited in footnote 4.

[7]. Washington Post. U.S. Steel, Marathon Oil Seek to Merge. Nov. 20, 1981, pp. A1, A9. _______. U.S. Steel: Nonsteel is Savior. Nov. 20, 1981, pp. D8-D9

[8]. DeYoung, J.H., Jr., and P. N. Yasnowsky. Capital Formation in the Nonfuel Mineral industries—A Literature Survey. U.S. Geol. Survey, 1980.

> Also, these companies may be producers of several minerals. For example, available data for "mining" plant and equipment expenditures and profitability are for companies assigned to the "mining" category on the basis of major economic activity. In addition, coal mining is included in the mining data.

Keeping the aforementioned data difficulties in mind, discussions of the impact of the severance taxes in Western States, the Economic Recovery Tax Act of 1981, and the recent high interest rates phenomenon follow.

2. Severance Taxes

Like all businesses, mining companies are subject to various taxes on their operations, by the national, State and local governments. Depending on the size and nature of the business, these taxes vary in kind. However, the severance tax is one of the unique kinds of taxes that applies to natural resources such as timber, fish, and minerals[9]. For this reason, in many States where severance taxes are enacted, officials of mining associations complain that the severance tax is discriminatory.

All of the Western States, except California, that are considered in this study have severance taxes on nonfuel minerals. The following tabulation summarizes in a simplified form the major metal severance taxes in selected Western States. Uranium is not included.

Arizona	2.5 percent of gross income.
California	No severance tax on metals.
Colorado	Molybdenum 15¢/ton. Other metals, 2.25 percent of gross income over $11 million.
Idaho	2 percent of net value.
Montana	2 taxes: (1) Graduated from 0.15 percent on gross value up to $100,000 to 1.438 percent on gross value over $500,000. (2) 0.5 percent of gross value over $5,000.
Nevada	Property tax rate of mine location applied to net proceeds.
New Mexico	2 taxes: (1) Copper, 0.5 percent of gross value; other, 0.125 percent. (2) Molybdenum, 0.125 percent of taxable value; other, 0.75 percent.
Utah	1 percent of gross value. Annual exemption of $50,000.
Wyoming	2 percent of gross value.

Source: Commerce Clearning House, Inc. State Tax Guide: All States. Chicago, Ill., 1980 with updated supplements, 2 volumes.

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[9] The Bureau of the Census defined severance taxes as "taxes imposed distinctively on the removal of natural products — e.g., oil, gas, other minerals, timber, fish, etc., — from land or water and measured by value or quantity of products removed or sold."

Any comparison of these taxes should be made with caution. There may be exemptions to the tax based on factors such as production or income levels, or a credit may be allowed for the payment of other taxes. Also, the value base, such as gross or net value, may have a unique definition in the State law. In short, the total tax system of Federal, State, and any local taxing jurisdiction must be consideed if the tax burden on an industry is to be determined. Even if the total tax burdens were determined, it is not clear how much effect taxation has on the location decisions of the mineral processing industry as opposed to other economic factors. Of course, this statement applies to reasonable levels of taxation only.

It can be seen from the above tabulation that most of the States use either a net value or a gross value base; however, these terms may be defined differently by each State. The only State using a physical unit base is Colorado (for molybdenum).

Idaho and Nevada use a net value (or net proceeds) base, and the other States generally use gross value bases. All taxes may be viewed as costs to individual firms. However, a tax using a gross value or physical unit base means that the tax must be paid regardless of the firm's ability to do so, (whether there is profit or not). A severance tax on net value (or net proceeds) is also a cost to the firm, but the ability to pay is assured since there is some profit.

The appropriateness of the severance tax is for the most part a subjective decision. There are no criteria with which to judge the appropriateness of the severance tax. Too much emphasis must not be placed on the rates because differences in the bases can more than offset any rate differences. Additionally, the apparent negative effect of the severance tax on a firm's cash flow is mitigated to some extent by its deductibility as a tax expense in computing Federal taxable incomes.

A positive aspect of some severance taxes for smaller mining operations is that these firms may be either exempt, totally or partially, or subject to lower rates. For example, Colorado's tax on metallic minerals (except molybdenum) applies only to gross income over $11 million. Montana's tax is graduated from 0.15 percent to 1.438 percent, and Utah exempts the first $50,000 of the gross value of the output from each mine.

In general, it appears that the severance tax burden imposed by the Western States on small metal mining is not exceedingly excessive. However, for any given mining operation, especially small firms operating on low profit margins, any increase in the tax expenditure could be the determinate of a firm's viability. The following observation by Blackstone is most appropriate:[10]

> It appears, therefore, that the economic effects of different types of taxes must be considered on almost a case-by-case basis, depending on the particular mineral involved, the characteristics of the deposit and the firm, and the market conditions for that mineral at any particular time.

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[10]. Blackstone, S. L. Mineral Severance Taxes in Western States: Economic, Legal, and Policy Considerations. Colo. Sch. Mines Quart., v. 75, No. 3, July 1980, pp. 1-39.

3. Economic Recovery Tax Act of 1981

The Economic Recovery Tax Act of 1981 has made a number of changes in the tax law that should be of benefit to all business enterprises, including small mining and processing operations. Among the changes significant to small mining are the reduction in corporate tax rates, the depreciation deduction, the investment tax credit, individual tax rate reduction, capital gains rate reduction, and the increase in accumulated earnings credit.

The present corporate tax rate structure is graduated as follows:

Taxable income (dollars)	Tax rate (percent)
0 - 25,000	17
Over 25,000 - 50,000	20
Over 50,000 - 75,000	30
Over 75,000 - 100,000	40
Over 100,00	46

In 1982, the rates for the first two income brackets, 17 percent and 20 percent, will be reduced to 16 and 19 percent, respectively. For 1983 and thereafter, the applicable rates will be 15 and 18 percent. These rate reductions will reduce the tax cost of doing business and, accordingly, increase cash flow, thus making more funds available for investment.

The most heralded change in the tax law affecting business made by the Economic Recovery Tax Ac of 1981 is the replacing of the system of depreciation based on useful life with the Accelerated Cost Recovery System (ACRS). Under the ACRS, the cost of depreciable personal (as opposed to real) property is recoverred over a period of either 3, 5, 10, or 15 years. Light-duty trucks and research and development equipment are included (with other items) in the 3-year category. Most business equipment and machinery is included in the 5-year category. The cost of real property can be recovered over 15 years. In all cases, however, the taxpayer has the option of choosing longer periods of recovery. In addition, a choice of using the straight-line method or a prescribed accelerated method (applicable only to the regular recovery period) is available. The effective date for the ACRS is January 1, 1981.

The concept of useful life in computing the depreciation deduction is in accordance with the accounting principle that revenues and the associated expenses be matched for the relevant period of time. Under the ACRS, the write-off period for a specific depreciable item will be shorter than it would have been under the useful life system. Therefore, there will be an increase in cash flow in the earlier years because of the larger depreciation deductions in computing taxable income. Note, however, that the total depreciation deduction on an asset still cannot exceed the cost. The advantage is having the funds available at an earlier period of time. This is particularly important in times of inflation when the replacement cost of an asset quickly becomes greater than its original cost.

Changes were also made in the investment tax credit, which was based on an asset's useful life, to conform to the changes in the system of depreciation. The investment tax credit is now 6 percent for eligible 3-year recovery property and 10 percent for eligible property recovered over 5, 10 or 15 years from the 7 years previously allowed. The carryback period of 3 years remains unchanged. It might be noted that this is a tax credit, which is a dollar-for-dollar offset against taxes, whereas a deduction, such as for depreciation, only reduces the income subject to tax.

These tax law changes, particularly the ACRS and the investment tax credit, provide major incentives for investment in capital-intensive industries such as mining and mineral processing. However, there must be profits (income) in the mining industries if the depreciation deduction is to be of any value. Also, there must be taxes due on this income if the investment tax credit is to be utilized. The problem is that profitability in the mining and processing industries has been rather low and cyclical for a number of years. Financial data for small mining operations are not abailable, but a dismal financial condition may be inferred from various individual statments and from the data covering the larger mineral-related companies. In short, the mining companies need to be profitable to benefit from these tax law changes. The tax law does provide for a carryback and carryforward of net operating losses and unused tax credits to profitable years. However, in the case of a carryforward, the credit or deduction is deferred to future years and is not available immediately, when it is needed most.

As noted, the ACRS and new investment tax credit changes are effective for property placed in service on and after January 1, 1981. The property placed in service prior to that time will continue to be handled under previous rules. Therefore, the benefits from the new tax law will essentially be phased in as new investments are made. Thus, if the problem is one of remedying the immediate profit situation, the new tax law changes will not help significantly.

There has been considerable interest in the new equipment leasing provisions, which enable companies to transfer investment tax credits and depreciation deduction to companies able to use them. At least one major mining company has been reported to have sold some of these tax benefits. However, it is too soon to know the extent to which such transactions will be undertaken, especially by small mining enterprises.

Additionally, the following changes in the tax laws due to the Economic Recovery Tax Act of 1981 are expected to be of significance to small business and hence small miners.

According to the U.S. Chamber of Commerce, nearly 90 percent of all businesses are sole proprietors, partnerships, or subchapter S corporations and pay taxes at the individual rates. Therefore, the 3-year, across-the-board rate cut and the drop in the top rate from 70 to 50 percent for all types of business and investment income as of January 1, 1982, should result in increases in smaller firms' cash flow. These funds could then be used to pay off debt for working capital needs or to acquire additional assets.

Another change is in the capital gains rate of taxation. The maximum capital gains rate is dropped from 28 to 20 percent for investments made after June 9, 1982. it is anticipated that the lowering of the maximum capital gains rate will generate increased investment and economic activity as taxpayers respond to lower marginal tax rates. If this becomes a reality, the increase in the pool of funds available for investment should make it easier for small firms to attract funds for capital expenditures.

Another source of funds for businesses is accumulated earnings. For the small corporation the increase n the minimum accumulated earnings credit may provide the opportunity to accumulate funds for capital expenditures without penalty. The minimum accumulated earnings credit is increased after December 31, 1981, from $150,000 to $250,000. This will enable firms to accumulate a maximum of $250,000 and not be subject to tax even though the money is not distributed to stockholders.

The effects of the Economic Recovery Tax Act of 1981 on industry sectors and on the whole economy will be realized over time. Investments are made in anticipation of future profits, and the new tax law was enacted to enchance the chances for future profitability. However, there are those who assert that if major and immediate results in the form of improved financial conditions for small mining and processing firms are expected, the tax law changes are not sufficient.

4. High Interest Rates and Small Miners

Small miners often must borrow in order to conduct production activities well in advance of the justifying output.

Interest rates above accustomed levels influence the viability of a business enterprise in one direct and in two indirect ways. First, high interest rates require the firm as a borrower to devote larger amounts from its cash flow to debt service. Further, they forecast the need to anticipate a larger flow of funds from any prospective additional projects. While important, this internal impact is perhaps not a critical as are two less appreciated indirect ways in which high interest rates affect a firm: (1) As a seller to customers who often borrow to some extent to finance purchases, firms encounter reduced or unstable sales flow if rates squeeze buyers; (2) As actual or potential customers of intermediary lenders who must place funds to support payout commitments to depositors, firms find themselves subject to lender strategies designed to deal with high interest rates.

Roughly the last half of this analysis specifies how high interest rates working through the three channels indicated above might affect small prospectors and miners. The potential damage from an extensive, though probably not exhaustive, list of interest-rate-connected prblems for that group cannot be interpreted in isolation. The first hal of the discussion sets a necessary context for what follows by exploring the range where a high interest rate might be found.

Nominal interest rate magnitudes exaggerate the burden even pereninal borrowers bear. During periods of inflation, lenders are repaid with money that will buy less than the money initially lent. The implication is that the borrower returns a smaller share of the fruits of his efforts than the original credit agreement intended. Lenders strive to avoid being penalized in this way be adding a premium to the interest rate applied to loans to compensate for the inflation they anticipate. Borrowers are presumed to acknowledge this inflationary bias by agreeing to higher nominal interest rates. The burden probably lies with the lender, though, to estimate future inflation and to persuade hesitant customers of its magnitude, ex ante. Analysts, in turn, adopt the convention of dealing with real interest rates, usually treated when examining economic decisionmaking.

The long-term level of real interest rates would not appear to be particularly deleterious to borrowers. Table IVB-1 presents an average annual inflation rate and a real interest rate for the past 3 decades and for the past 3 years. The real interest rates in the table are computed as the difference between the average yield on long-term Government securities and the actual increase in the wholesale price level. Small miners cannot borrow at the same nominal rate as the Federal Government, nor is all their borrowing long term. Nevertheless, assuming that the term structure of interest rates has not widened substantially since 1950, this calculation gives a reasonable indication of level and the trend in real interest rates. On average, real interest rates were apparently lower during the 1970's than during the 1950's and 1960's. Only in the last year have they begun to rise. Twelve months more or less is not long enough to allow declaration of a trend turning point. Even if it does mark the beginning of a secular rise in real rates, rates must increase considerably to make the 1970's to 1980's change worse for borrowers than the 1950's to 1960's change.

TABLE IV B - 1 - Trends in inflation rates and in real interest rates, 1950-81

Period	Percent change in average annual producer price index	Average annual risk free real interest rate
1950-59	1.50	1.50
1960-70	1.51	3.30
1970-79	8.78	-1.17
1979	11.12	-1.68
1980	13.45	-1.99
1981	[2]7.85	5.33

1. Year-to-year change in producer price index for total finished goods subtracted from yields on 10-year, constant-maturity U.S. Treasury securities.

2. August 1980 to August 1981, percent change.

3. Arithmetic average yield from Setpember 1980 through August 1981, for 10-year Treasury securities minus 7.85.

Sources: Boskin, M. J., et.al. The Impact of Inflation on U.S. Productivity and Competitiveness. National Planning Association, 1980., pp. 4, 6
Economic Indicators, September 1981, Council of Economic Advisers pp. 22, 30.

The above analysis can do no more than set a context, however, for discussion of the situation of a particular set of borrowers. Further, at least three complications must be kept in mind when imputing real interest rates as computed in table IVB-1 to private firms in one industry: (1) Risk elements are absent from Government rates; (2) price performances vary among industries, and (3) tax rates ignore inflation.

The risk element, covering such uncertainties as the degree to which future market, price, and political developments will constrain the firm's ability to service debt on time or at all, accounts for the premium private borrowers must pay relative to public borrowers. Additional risks associated with unknown manager competence and limited flexibility are probably primary reasons why small firms often face even higher rates than large established firms. Relatively meager internal funds mean that small firms not only have less resiliency when hit with the consequences of misjudgments or bad luck, but also must resort more completely to external or conventional debt finance. Hence, small firms can be expected as a rule to face real interest rates significantly above those depicted in table IVB-1. It is unclear whether that gap or penalty tends to rise during periods of escalating general rates.

Another complication arises because it is unlikely that the real interest rate for a small group is equal to the difference between a general nominal rate level and some available aggregate measure of inflation. In particular, if the prices this group typically gets from its customers have not kept pace with the broad inflation measure, the debt service can claim a larger share of the borrower's real revenue than implied by the aggregate real interest rate.

Many will admit that metals prices have not risen as much, or at least as consistently, as have most other prices in recent years. Where quantity has not increased enough to compensate, revenue also will not have kept up with inflation on average. If these suppositions fit, then mineral producers have been subjected to higher real interest rates than have others whose prices matched or exceeded the inflation trend. It may be that lenders recognize this effect and, in the interest of diversifying their loan portfolios, offer concessionary nominal rates to borrowers with currently lagging prices. To the extent that lender adjustments are not made, firms whose prices do not keep up with capital and operating costs (i.e., general inflation) do confront higher real interest rates than firms in other industries.

It is not at all clear, however, that this effect is unjust. Metal prices and revenues may not have kept up with inflation because consumer tastes favored other products or were influenced by lower cost imports. High real interest rates relative to other sectors may then be viewed as part of the competitive pressure exerted by consumer sovereignty to reallocate resources to more desirable utilizations. The pressure may not be that coercive in any event owing to the third complication with using real interest rates as usually conceived.

Taxation of interest income is based on nominal returns. Thus, by not acknowledging the decisionmakers' adjustment for inflation, authorities collect what might be termed a "surtax" from lenders. While preserving the value of his money, the lender is made to pay a tax equal to his bracket times inflation times his loan. Borrowers benefit because their contribution to the predetermined tax total extracted from the economy is correspondingly reduced. If they can deduct interest costs from their taxable income, borrowers are further rewarded by inflation. Loans repaid with nominal interest removed from taxable income have the effect of reducing real interest rates below the level found by deducting the inflation rate from the nominal interest rate.

High interest rates would seem to penalize borrowers' operations only when they are so high that they exceed the subsidy inherent in inflation and the tax incidence plus whatever the appropriate price is for the use of money before it is earned. For example, if inflation is expected to proceed at 10 percent annually the tax distortion is measured at 4 percentage points[11] and the time cost of money plus a premium to defray the risk associated with a particular project or firm is 6 percent; only interest rates above 20 percent are "high" relative to competitively efficient levels. Serious problems attributed to high interest rates that are not this high probably are more reflective of poor project choice, mismanagement, or some other defect from which the firm has no right to be rescued. In reality, hih interest rates that are not this high present net rewards, not problems, to borrowers.

Within this rather supportive atmosphere, do mineral firms come out less well off than other firms generally? If the combination of such things as small size, royalty expensing, and depletion allowances holds the taxable income of small miners below the tax brackets of most other enterprises, the answer is yes. The subsidy offered by the opportunity to deduct inflated interest rates is smaller than for firms exposed to higher tax brackets. Since such an effect is predicated in part at least on already granted tax benefits, it is again not clear that small miners deserve relief from this effect.

Thus, in an inflationary environment and with the existing tax system, nominal interest rates must be quite high to impose any burden on borrowers. Small prospectors and mines may be less well situated to adjust to sharply higher nominal rates. However, it is difficult to make a case that they are unfairly victimized by this situation alone. More specific considerations indicate that small miners can be affected in many ways other firms probably are not, when high interest rates develop.

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[11] Assume $1 million is loaned at 20 percent. Interest payments total $200,000 annually, of which $100,000 is an inflation premium designed only to preserve the value of the principal. The lender pays income tax on $200,000, and the borrower deducts $200,000 from his taxable income. If both are in the 40 percent bracket, the lender can be said to pay $4,000 too much tax. If Government must have the full $40,000, the borrower probably should compensate the lender by paying an extra $40,000, or 4 percent interest. Deduction of nominal interest does reduce the borrower's tax liability by $80,000, of which $40,000 is for an inflation adjustment payment.

Experts contend that a greater percentage of expenses for small business is subject to changes in interest rates than is the case with larger enterprises[12]. Seasonal and other fluctuations in expense and receipt flows apparently tend to be larger relative to overall cash flow for small firms. Consequently, greater inventories of output, materials, and accounts receivable relative to production flows must be financed. It is not hard to envision how circumstances typical of mining firms add to any special problems higher interest inflict on small firms generally.

Remote operations probably entail carrying larger stocks of critical components and maybe even of large equipment than is necessary for firms operating in high-density commercial areas. Certaintly, high interest rates encourage parts suppliers to find ways to reduce their inventories. If suppliers of inputs for mineral activities react by producing less for speculative sales and more for firm orders, small purchasers particularly may be forced to buy more, less often and hold material for longer periods than previously to preclude crippling shutdowns.

High interest rates can also add to the pressure from drawn-out land use and permit disputes. Mineral reserves are in a real sense an inventory item. Expenditures made to ascertain the location and extent of promising ore reserves cannot be recouped until production has begun to yield profits or until rights are sold. The longer that lag lasts, the larger are the financing costs borne by equity interests. Higher interest rates obviously increase the cost of any delay.

Operations characterized by quick growth followed by slow decline to a stage dramatized by the image of a ghost town can run into chronic debt service problems. Obligations incurred during the initial rapid growth period must of course be met out of subsequent earnings. Uncertainty over commodity price fluctuations is probably paired in mining with inevitable but not always fully predictable cost escalation as ore grades and accessibility decline over the finite life of a project. Those complications to planning for sufficient debt service set-asides tend to produce occasional misjudgments that impose unexpected financing demands while corrective action is untaken. Modest internal cash flows cannot as easily absorb such net expenditure surges without resorting to external debt obligations. While resource-poor firms in general face this hazard, more stable products price trends, indefinite operating lives and the absence of a natural force pushing up unit costs can reduce the chances that a small manufacturing firm temporarily must take on expensive credit obligations.

Even basic progress can result in unusual interest penalties on prospecting and mining ventures. In response to ore grade declines, periodic enlargements and improvements in capital equipment have become available to mineral enterprises. That opportunity tends to induce reentries into the debt market for renovation funds to meet the competition, which firms in less innovative industries can escape. A related pressure to incur debt follows from the fact that human and environmental danges in mining probably have been longer and more fully recognized than in most commercial and manufacturing operations. The relatively recent increased stringency in waste product and worker safety standards usually necessitates capital spending, just as do purchases of other equipment.

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[12] Welsh, J. A., J. F. White. A Small Business Is Not a Little Big Business. Harvard Business Review, v. 59, July-August 1981, pp. 18-32.

If these various influences have forced miners to stretch out repayments or make lumpy purchases to a greater degree than have firms in other industries, the attendant borrowing at high interest rates is overly burdensome both to those firms and to society generally. Such often thinly capitalized ventures may well be forced to eschew potentially attractive projects because of unusual financing difficulties rather than because of poor economics. The conventional advice to small enterprises is to pursue liquidity rather than maxiumum return on investment. To the extent that small miners follow that advice, their individual loss is more in an opportunity-cost sense than in a real, tax deductible sense. Regardless, it is conceivable that by intimidating small borrowers into financial frugality, high interest rates can deprive this country of some of the benefits available from additional domestic mineral production.

In addition to direct problems associated with the need to borrow external funds, small mineral producers can encounter indirect difficulties due to high interest rates. Most of the output of primary goods producers is bought by finished goods manufacturers. When high interest rates among other factors, reduce sales by auto, appliance, and construction implement makers, they slash orders for raw materials. Not only do they need less aluminum, copper, zinc, etc., products for current output but also interest rates make it more expensive to hold as large an inventory of parts relative to production rates. Also, as sales by fabricators, refiners, and smelters drop, these operations can be expected to adopt conservative inventory positions.

By the time sales declines have spread to the extraction stage, they can be quite dramatic and dangerous. From the processor's point of view, it is probably most prudent to direct what purchases continue to its captive mines. Independence may grant non captive mines the freedom to exploit strong markets, but it also tends to expose them to the extremes of a sales drop.

Traditionally, such independent companies have survived because of strong ebounds, when sales pick up again, in the value of their accumulated inventories. If a critical payment during the waiting period cannot be met, however, the producer will not be around to benefit from a surge in the value of his inventories. High interest rates can make such inadvertent speculation more expensive to conduct, and can increase the chance of bankruptcy by a firm caught in this precarious siuation. During accumulation periods, small mine operations can become vulnerable to takeover by other firms whose larger cash reserves or credit lines permit more patience. Previous lenders, nervous over the security of their outstanding loans to small firms trying to hold on, may coerce such combinations. If the desire is to preserve independnet mining operations, rather than domestic production capacity, the consolidation route is not welcome to policymakers.

It is perhaps too much to attribute all the problems stemming from a slowdown in the sales of finished goods to high interest rates. They certainly are a contributory factor whose impact can become unbearable when paired with the direct borrowing difficulties high interest rates cause for small miners. The insidious nature of this indirect affect may cause more casualities among small miners than the more apparent high borrowing costs. Fortunately, general reaction by lenders may brighten the rather gloomy prospect high interest rates hold for mineral borrowers.

High interest rates do not dampen and may even intensify the incentive lenders have to place responsible loans. As has been noted, high interest rates are due in large measure to inflation and in particular to uncertainty over its future course. The widely noted collapse recently of the long-term bond market indicates that by and large lenders have responded by concentrating on short-term instruments. It should be kept in mind, however, that savers and their institutional intermediaries cannot afford to idle large amounts of funds while inflation and earning distribution obligations continue. The more crowded the supply half of short-term credit markets becomes, the more attractive alternatives must appear.

Under such pressure bankers and other institutional investors may be more receptive to loan request from less traditional clients like mines. Those rather risky activities do offer the chance for long-term business if they eventually prosper, along of course with the possibility for substantial loss. Lenders are reportedly beginning to accept and even seek such borrowers by taking on some of the project risks with financing packages that contain equity elements[13]. For example, some banks have apparently become willing to synchronize a debt repayment schedule with volatile cash flow streams. Competitive and market pressures do not prod only manufacturing and mining business to become more innovative and responsive.

One cannot be certain that any benefits produced by this competition will be shared equitably by large and small borrowers. Fundamental lender conservatism would seem to favor mineral projects with attributes more easily assembled by larger companies. It is often the case in mining operations that unit costs fall over an extended range of output. Consequently, larger projects can be more profitable in good times and can be more apt to generate sufficient cash flow to service debt at some minimum level while commodity prices drop. Projects that include customer as well as producer sponsorship encourage lenders to accept longer debt repayment periods. by including prospective customer utilities, for example, recent coal and uranium projects have offered investors added assurance about long-term markets and maybe even prices.

Several small companies can form joint ventures in an effort to offer these desirable attributes to the lender. However, the absence of a previous project development record by such a combine might still trouble lenders or partners who lack technical competence at resource development activities. Completion complications may be thought more likely to overwhelm even several small firms than larger companies with greater financial resources available in case of need. The often-mentioned situation of small businesses borrowing at interest rates several percentage points above prime is reflective of their relative inability to inspire lender confidence.

Admittedly, the above speculation about lender bias in favor of large firms is rather tenuous. It does seem more reasonable than trying to argue that any such bias is reversed. A combination of factors at least seems to suggest that large borrowers may be considered first if lenders' inclination to make mineral industry loans increases.

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13. Pike, R. E., and J. T. Thibodeau. The Role of Banks in Mining Projects. Mining Magazine, v. 145, No. 4, October 1981, pp. 285-288.

In summary, until quite recently the level of interest rates relevant to individual decisionmaking has been low, even negative, for an extended period. Borrowers gain rather than lose relative to the rest of the economy in this situation. For a variety of reasons mineral firms, small ones in particular, are exposed to the direct and indirect influence of interest rates. Whether collectively they actually impose greater damage on small prospectors and miners when rates surge than is true for other groups cannot be determined without substantial empirical evidence. It does seem fair to say that the diversity of impacts implies that narow policies designed to compensate for specific effects on this group are likely to be much less helpful than the reduction of interest rates generally. That development, however, would conflict with the more general concern about the paucity of savings of late. Further, sudden borrower penalties must be weighed against the rewards bestowed by previous interest rate levels.

Traditionally, the Government has tried to enhance the profitability of businesses through reductions in tax rates and/or the granting of tax credits. Although these methods are thought to be effective, tax policy will only help those companies that already are earning some profit. Many small companies operate on the fringes and are therefore unable to take advantage of these tax "breaks." However, all mining companies feel the impact of excessive Government regulations. The capital costs of compliance represent a diversion of capital from productive uses. Mining industry officials state that "Trade offs between uneconomic regulation" and economic progress need to be made. The "use of tax policy as an instrument for guiding the private sector toward certain goals would be far superior to direct regulation from both an economic cost and an efficiency" standpoint[14].

Additionally, perhaps the solution to the profitability problems of small miners lies with the market, i.e., in higher prices for metals. Thus, the only role for Government then would be to allow the market to operate unrestrained.

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[14]. Page 30 of work cited in footnote 4.

IV. C. Impact of Government Policies on Mining

A HISTORICAL REVIEW OF U.S. MINERAL POLICY, 1940-1980

This section reviews U.S. mineral policy during the years 1940 to 1980 with special emphasis on the antimony, cobalt, copper, gold, lead, molybdenum, silver, tungsten, and zinc industries and references to the effect on the small miner. The reasons for policy action and the results obtained are examined where possible. All information was obtained from reports found in the U.S. Bureau of Mines Minerals Yearbooks, Volume 1, 1940 through 1980.

The most significant policy initiative taken in behalf of the small miner was the Mining Law of 1872 and its amendments; the result was an industrial base second to none in the world. Since that time, specific policy initiatives made solely to promote the development of mining, and the small miner in particular, have been few. Most U.S. legislation affecting the mineral industry in the past 40 years has been made in response to short-term demands of unstable and/or wartime economies or to demands from special interest groups concerned with protecting and preserving the environment. When the wartime effort ceased, the Government supports were often withdrawn; there were no long-term or consistent policies motivated by an awareness of the need for growth in the mineral industry. In contrast, the mineral policies of other countries have been prompted most often by the need to develop and promote a mineral industry base. As a result of these motivational differences, the policies put forth and the results obtained have been vastly different.

Wartime needs prompted various policy initiatives to increase and assure supplies for both the United States and its Allies because of shortages caused by defense buildup and the cessation of certain sources of supply. The overheated economy during the war and the unstable markets in the years that followed also required special legislation to stabilize markets and mineral supplies. Increased domestic supplies were usually promoted through tax incentives, loans, price guarantees, purchase agreements, exploration and development assistance, technology research, and construction of roads and access. Development of new domestic sources of metals such as tungsten, cobalt, gold, and uranium was at least a short-term benefit of many of these policies. Foreign sources were promoted through investment incentives, export-import loans, foreign aid, and various materials purchase agreements.

Measures to assure supplies included equitable allocations systems that were set up for both domestic and international minerals allocations. Special international trade agreements also were made with supplying nations. During World War II, aid to the Allies included the lend-lease of 410.8 million ounces of silver because the United States had the largest stock of silver in the world. It was ironic that the return of this silver during the 1950's served to further depress silver prices, and was a detriment to the development of the silver mining industry. In an effort to solve labor problems during World War II, War Production Board Order L-208 of October 1942 (rescinded in July 1945) had the avowed purpose of providing manpower and equipment for nonferrous metals essential to the war effort. The War Production Board had declared gold mining as nonessential. According to this order, no former gold miner could obtain a new job west of the Mississippi and all former miners were to be assigned only to nonferrous mining jobs. The principal effect of the order was to restrict domestic gold mining to the extent that many gold mines were compelled to close.

The gold mining industry was to later contend that this order amounted to a violation of constitutional rights and by 1955, 217 companies had initiated petitions in the U.S. Court of Claims for compensation of damages resulting from this order. The Court of Claims found in favor of the miners, but this was later overturned by the U.S. Supreme Court. Gold mining was never to recover to its pre-World War II levels. U.S. monetary policy also kept the price depressed at $35 per troy ounce until the 1970's, when the gold relationship in international monetary exchange was changed and the price was permitted to rise according to the marketplace. This policy was to serve as a boon to the gold mining industry by the late 1970's.

Material shortages created during World War II prompted the creation of a National Defense Stockpile late in the 1940's. For the next 30 years, the preparation for a national emergency was to form the backbone of U.S. mineral policy. The Government materials stockpile became an instrument used widely as an economic buffer; beginning in the 1950's, mineral goods were sold in times of shortage and bought in times of surplus. Often, however, this manipulation did not take place quite that smoothly. Long-term purchase and/or sales contracts often ran past the period of shortage and/or excess. Sales in the 1960's and 1970's also seemed to bear little relationship to the demands of the marketplace, and served mainly to stabilize and depress domestic prices to the detriment of the mineral industry. Sales of tungsten in the 1970's were made to foreign countries and were almost as large as the entire domestic production for several years running. Sales were often motivated by the need to balance the Government budget or to stabilize prices rather than by a concern for the health of the mineral industry. Stockpile philosophy changed over the years from 5-year to 3-year to 1-year levels of preparedness, creating huge surpluses. In 1976, the stockpile goals were revised again to a 3-year basis, but it was too late to save many of the strategic items sold.

Measures to stabilize the economy were applied frequently throughout the period, and all of them were to have some negative effect on the mining industry. The small miner is particularly sensitive to changes in mineral prices. Price controls, stockpile sales and purchases, monetary restrictions, and other manipulations served mainly to artificially depress or raise prices, making the U.S. mineral industry noncompetitive in the face of rising production costs and/or foreign competition. At times the Government actually promoted foreign industry to the ultimate detriment of the domestic mines. The tungsten industry of the 1950's was an example. Early in the decade, with guaranteed prices well above those of foreign producers, domestic tungsten producers sold directly to the Government stockpile while domestic consumers were buying from cheaper foreign sources. The foreign sources, meanwhile, benefited from U.S. Government loans for development and from long-term purchase contracts, which ran past those of domestic producers in the late 1950's. Many domestic producers of tungsten, who had expanded due to the Government purchases, closed; there were 700 tungsten mines in 1954 and only 2 in 1958.

A rising concern with the environment, safety in the workplace, and wilderness conservation prompted a series of governmental actions that started late in the 1960's and reached a peak in the 1970's. Legislation was passed in Congress addressing many subjects of concern to the minerals industry, including the environment, endangered species, preservation of historical sites, reclamation of mining lands, energy, water quality, public land withdrawals, special leasing acts and mining laws, black-lung disease benefits, and consumer and labor safety. These requirements, coupled with rising fuel and operating costs, labor strikes (which occurred nearly every year), manipulations of the national strategic stockpile, and general governmental economic policy actions to combat inflation and the deteriorating value of the dollar, were to have a continuing negative impact on most of the mining industry. Foreign mineral policies, such as increasing raw material processing, nationalization of U.S. foreign investments. Government supports for certain mineral industries, the formation of mineral associations and cartels, excessive pricing of petroleum by OPEC nations, LME pricing policies, and changing international monetary policies, were also to be felt by the U.S. mineral industry in the 1970's more than ever before.

The result of U.S. attitudes and policies towards the domestic mineral industry has been one of steady decline. Only a few metals such as molybdenum and lead have shown any steady growth in production capacity in the past 40 years that is sufficient to keep pace with consumption, and most of the metals industry has experienced a progressive increase in import reliance. The United States no longer possesses the world's largest stock of silver, and the Treasury gold reserves have shrunk from about 629 million ounces in 1953 to 264.3 million troy ounces in 1980.

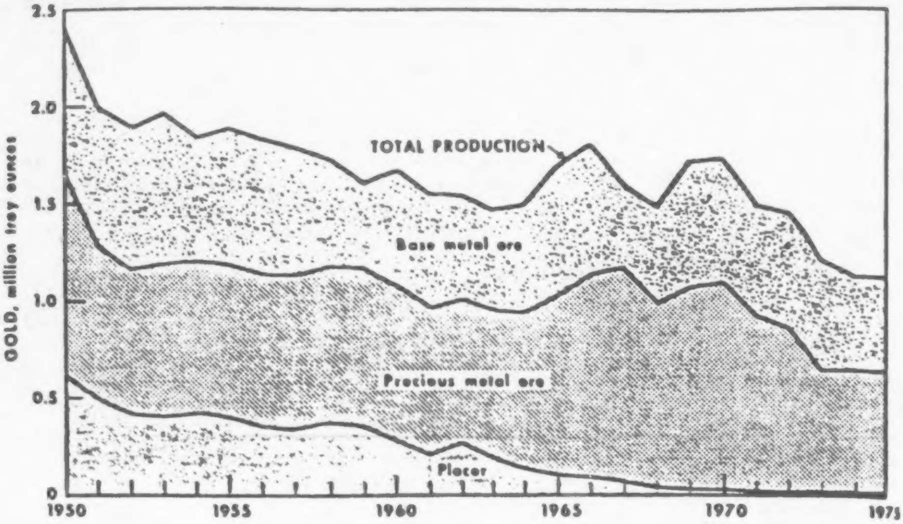

Figure IV. C-1 -- Gold Production in the United States, 1950-1975 (Bureau of Mines Minerals Yearbook, 1975)

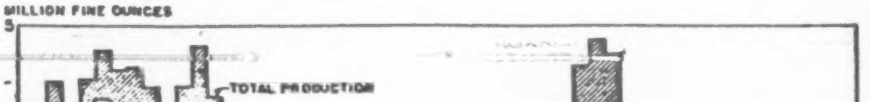

Figure IV. C-2 -- Gold production in the United States, 1905-1954 (Bureau of Mines Minerals Yearbook, 1954)

IV. C. 2.

U.S. MINERAL POLICY IN THE 1940's

The first half of the 1940's was characterized by rapid mobilization for war production, while the latter half saw a winding down of war production and measures taken to avoid such oversupplies of materials from war-stimulated mines as had happened after World War I. World War II policy was to increase production of minerals through direct Government contract or subsidy rather than to broadcast appeals to the public as was done during World War I.

1. Measures to regulate supplies:

In addition to the permanent Government bureaus, several temporary Government organizations were in existence during the 1940's, all of which had some responsibility with regard to the production, procurement, distribution, and prices of mineral raw materials. The Office of Production Management and Office of Price Administration were originated in 1941. Government programs were carried out chiefly through the Metals Reserve Co. and the Defense Plant Corp., both subsidiaries of the Reconstruction Finance Corp., and all placed under the Department of Commerce in 1942. Also in 1942, the War Production Board replaced the Office of Production Management; a Combined Raw Materials Board was set up by the United States and Great Britain for the most efficient use of raw materials of the two nations; the War Manpower Commission was created to plan for the most effective use of manpower; and the Board of Economic Warfare formulated policy and directed procurement of foreign materials for war purposes.

Legislation was enacted throughout the decade to regulate mineral supplies, beginning in 1939 with passage of the Strategic Materials Act (PL 117). This law authorized expenditure of $100 million over a 4-year period for the purchase of strategic materials. A subsequent Third Deficiency Bill (PL 633) appropriated only $10 million and purchases were restricted largely to the high-priority mineral commodities on the strategic list -- manganese, chromium, tungsten, tin, and quartz crystals. The act also provided for the investigation of domestic sources of strategic minerals by the Bureau of Mines and the Geological Survey.

The Emergency Price Control Act of January 30, 1942, and an amendment dated October 2, 1942, allowed the Government to control prices on virtually all critical materials.

Various regulations were in effect pertaining to specific minerals. Most notable was the Premium Price Plan, which went into effect in January 1942 to expand domestic output of lead. The plan authorized lead producers to receive 9.25 cents a pound for lead produced in excess of quotas based upon 1941 output as against the ceiling price of 6.50 cents established on the same date. Production of copper and zinc was also stimulated by the Premium Price Plan at mines where all three minerals were produced. When increased production of zinc became necessary, the Premium Price Plan was amended with an additional premium price level for lead at those mines that produced both minerals, and a premium price of 11 cents per pound for zinc produced in excess of 1941 output quotas at the ceiling price of 8.25 cents per pound. The Premium Price Plan was in effect until mid-1947.

Also notable was the War Production Board Limitation Order L-208 of October 1942, which identified a nonessential mine as any mining enterprise in which gold was produced. As a result of this measure and one that prevented former gold miners from obtaining new jobs west of the Mississippi, gold mining effectively ceased during the 1940's.

After World War II the Strategic and Critical Stock-Piling Act of July 23, 1946, authorized the procurement of stocks of strategic and critical materials by purchase, by transfer of surplus war stocks owned by the U.S. Government, and by reverse lend-lease payments from foreign governments. This was an amended version of the Strategic Materials Act of 1939.

2. Mineral summaries:

Antimony.--After dislocation of the Chinese antimony industry in 1937, output came principally from the Yellow Pine mine in Idaho, augmented by mines producing under Government allocation throughout the decade. During the war new uses for antimony oxide in flame-retardant textiles were developed that had carryover applications in civilian markets. As a consequence, prices rose dramatically after price ceilings were lifted in 1946.

Cobalt.--Production of cobalt before 1945 was relatively small, and world output was insufficient to permit much expansion in use of the metal. However, during World War II the capacity of mines to produce ore and of refining plants to provide metal was expanded phenomenally. As a result, there were adequate supplies for industrialists interested in post-war expansion of permanent magnet production for use in radio, electricity, electronics, and a wide variety of machinery and household equipment. Price controls were removed in 1946, but because of large world supply, metal prices increased only gradually. The Belgian Congo was the world's largest producer, while Bethlehem Steel Corp. led U.S. suppliers with byproduct cobalt from its Cornwall iron mine in Pennsylvania.

Copper.--World demand for copper in the early 1940's far exceeded supplies; in the United States copper was placed under industry-wide mandatory controls. Bonus prices were paid by the Metals Reserve Co. for above-quota production; exports were confined to essential needs of allies; efforts to produce copper from scrap were increased; exploration and drilling operations by the Bureau of Mines and Geological Survey were increased; lending policies of the Reconstruction Finance Corp. were liberalized. On the other side, the War Production Board ordered reduction of copper in many necessary items and discontinued use of copper in thousands of civilian products. By 1943 these measures had brought supplies and essential requirements into balance, and copper was no longer the outstanding critical metal. After the war there was no evidence of satiation of demand, and domestic supply fell short of capacity, largely as a result of labor problems. Copper mining proved relatively unattractive to men returning from service, and strikes characterized the copper industry throughout 1946. After price ceilings were lifted in 1946, yearend prices had risen 60%, causing concern for the possibility of large-scale substitution of aluminum. The low rate of production was paralleled abroad. Continued domestic demand and Government purchases for the strategic stockpile, however, permitted a healthy industry at the end of the decade.

Gold.--Gold mining in the United States experienced more adverse effects from U.S. participation in World War II than any other large mineral industry. By 1940 U.S. stocks of gold had risen to 66% of the world total, but gold and silver mining was excluded from priority benefits in 1941. In 1942 the War Production Board identified a non-essential mine as any mine that produced gold. Another order ruled that no former gold miner could obtain a new job west of the Mississippi; all former miners must be assigned only to nonferrous mining jobs. Miners left the mines to seek higher wages in defense industries. By 1944 gold output was only as a byproduct of base-metal mining, and when restrictions were relaxed in 1945, the industry responded sluggishly. Lode mine equipment had deteriorated by then, and labor shortages continued. Gold mining remained a secondary operation at placer mines, which had not deteriorated as much, and which were nearer large population centers. Value of gold was fixed at $35 per troy ounce in 1934, and remained fixed throughout the 1940's.

Lead.--As an essential war material in direct military applications and a substitute to help relieve shortages of other nonferrous metals, lead was placed under Government control in 1940. This set up a system of allocation under full priority control and an emergency pool to take care of specialized needs. In 1942 the Premium Price Plan provided premium payments for production in excess of quotas based upon 1941 output; the premium was subsequently raised. By 1944 mine production decreased owing to depletion of developed ore reserves and the manpower shortage. The War Production Board further restricted consumption in an effort to ease the situation. When the war ended some civilian restrictions were relaxed, and ceiling prices were removed in 1946. Widespread strikes at principal mines, mills, and smelters paralyzed the industry during 1946, but an absence of labor problems in 1947, coupled with extraordinary consumer demand which boosted the lead price to recordbreaking levels, returned the lead industry to health. The latter part of the decade saw increasing recovery of lead from secondary sources which offset lowered mine production to satisfy continued high demand.

Molybdenum.--Owing to the abrupt rise in steel production in the United States in 1939, molybdenum was placed on the critical materials list. Anticipating the possibility that imports of tungsten might be curtailed and molybdenum needed as a substitute, a regulation in 1941 required that 75% of all high-speed steel orders in any one quarter must be of the molybdenum type and not more than 25% of the tungsten type. In 1942 molybdenum was placed under complete allocation as a conservation measure. By mid-1943 consumption leveled off and molybdenum was removed from allocation control. To stimulate domestic production and provide a ready market for concentrates, a small-lot purchasing program was started, which helped develop new operations. In 1944 all restrictions were removed from steel-alloying ratios. However, consumption of molybdenum continued to follow steel production throughout the decade.

Silver.--Although silver was excluded from priority benefits of Preference Rating Order P-56 in 1942, output was sustained at a substantial level because of high base metal production; 80% of silver production was from base metal operations. Production lagged by 1945 because higher grade base metal mines were depleted and silver content was much lower at remaining mines. Continued decline of silver production in 1946 was due largely to the strikes in base metal mines and at copper and lead smelters. The price of silver was fixed at $0.7111 per ounce from July 1939, until July 1946, when it rose to $0.905 for silver produced domestically. Although silver prices were freed late in 1946, they did not change. A post-war uptrend in silver production was reversed in 1949, owing largely to curtailed output of base metal mines.

Tungsten.--Tungsten concentrate was a high-priority commodity on the Strategic Minerals Act list in 1939. The closing of the Burma Road in 1941 cut off supplies of tungsten from China, but agreements were made with Bolivia, Argentina, and Mexico to purchase tungsten. Contracts were arranged with large U.S. producers to increase production, and with small producers for direct purchases. The Bureau of Mines continued to search for new domestic supplies. A labor shortage in the domestic industry was relieved when the Army released some soldiers to work in tungsten mines and the Metals Reserve Co. raised the price to further stimulate production. By 1943 these measures had proved successful, and supplies of both ore and concentrate exceeded requirements. Therefore, many restrictions were removed, including the removal of the premium price in 1944. By 1945 production was down, and some operations were discontinued. In 1947 the tool steel industry tried unsuccessfully to have some of the tungsten in the Government stockpile released; prices had reached record highs. The general recession in the steel industry in 1949 caused a further drop in tungsten output, and more operations were suspended.

Zinc.--Shortages of zinc in 1941 led to creation of a zinc pool equal to 5% of January output, which would be requisitioned from April production for defense industries. Pool requirements later increased to 75% of high-grade zinc and 50% of lower grade, based on January production. Increasing regulatory measures in 1942 expanded the zinc smelting industry and conservation measures resulted in a 12% drop in domestic consumption. Both remelt zinc and refined metal were placed under controls in 1943, and a premium-price plan for over-quota production was in effect. By 1944 the zinc industry met all essential demands, civilian as well as military, in spite of critical manpower shortages. All Federal controls were eliminated by 1945. Despite labor strikes and a drop in production and imports in 1946 and 1947, sufficient zinc was available to permit expansion of consumer stocks, and 1949 saw an increase in production and exports.

III. I. 3.

U.S. MINERAL POLICY IN THE 1950's

The Korean war began in June 1950, prompting a series of domestic and international U.S. policy measures to cope with the rapidly changing mineral supply situation. The umbrella act for most initiatives taken was the Defense Production Act of 1950, which was renewed every year and embellished and modified as needs changed. With the experience of World War II so close in memory, many of the measures taken were similar. The Government responded quickly to expected shortages of raw materials caused by the abnormal needs of a wartime economy. Policy initiatives were applied generally to (1) increase supplies, (2) assure supplies, and (3) stabilize a fast-growth wartime economy. Following the Korean war, the winding-down of the wartime economy and the dislocations that had resulted from previous policy initiatives necessitated continuing Government reactions to (1) stabilize erratic supplies and prices, (2) satisfy emergency preparedness requirements, and (3) bolster a sagging economy. All of these policies were to affect the small miner, who formed the backbone to increased domestic supplies in time of need; and with the exception of exploration assistance and tax amortization and loan programs, most policy initiatives, such as those affecting prices and supply, were to affect him so adversely that many small mines closed by the end of the decade.

1. Measures to increase supplies:

U.S. policy initiatives to increase supplies were applied to both domestic and foreign sources with varying success. The Defense Production Act of 1950 provided for substantial assistance for expansion of both domestic and selected foreign mineral production as well as for mineral exploration, construction of roads and access, establishment of priorities for material and equipment allocations, the bartering of agricultural commodities for minerals, technology research, and wage and price control. Domestic production expansion was also stimulated through an accelerated tax amortization program, loans, and purchase and price guarantees. The Atomic Energy Act of 1954 prompted even greater numbers of uranium mines, and the Atomic Energy Commission purchasing program was extended to 1962. Guaranteed production procurement contracts directed toward building up the national strategic stockpile were crucial to the development and survival of many mines, especially the U.S small miner. Many foreign operators were also dependent upon U.S. Export-Import Bank credits, as well as on U.S. Government guaranteed mineral purchase contracts and exploration assistance. Some were to argue later that some of this foreign assistance was to serve as a detriment to the U.S. small miner by creating an oversupply at unrealistic prices outside of the United States.

Of the 1,159 exploration contracts executed by the Defense Minerals Exploration Administration (DMEA) (superseded in 1958 by the Office of Minerals Exploration), discoveries or developments were certified for 386 at the end of 1959. The total value of 381 contracts certified and terminated was $26.1 million; the Government contractual share was $16.2 million. The potential ore reserves proved from all 386 projects were estimated to have a net recoverable value of $800 million at prevailing market prices. Numerous other exploration or research projects to expand or improve mining technology were undertaken by the U.S. Geological Survey, Bureau of Mines, National Academy of Sciences, Atomic Energy Commission, and other Government agencies. Foreign exploration assistance was also carried out through the U.S. Geological Survey (under agreements with the General Services Administration) and the Foreign Operations Administration in select nations such as Cuba, where the Survey prospected for refractory chromite and nickel.

To stimulate increased mineral production abroad, the U.S. Government through the Export-Import Bank made loans and gave credits for purchase of U.S. equipment and materials to many foreign country sources. For instance, the Bank established credits abroad that totaled $38 million for tungsten and manganese production in 1951, and $114 million in 1952 for the production of cobalt, copper, tungsten, manganese, nickel, uranium, and sulfur for the U.S. national strategic stockpile. In 1955, the Bank extended to the American Smelting and Refining Co. $100 million in credits for financing a copper project in southern Peru. Foreign Operations Administration (FOA) loans were also made to increase the capacity of the Rhodesian Railroads ($10 million) for transporting copper, and to the French Government to aid development of the Akoujt copper deposit in Mauritania ($1.4 million). The FOA also supplied technical advisors to some countries to assist in the development of mineral resources.

Stimulated immensely by the tax amortization program allowed under the Defense Production Act, U.S. private mineral industry investments in mining plant and equipment experienced new peaks in 1951. By mid-1952, however, a pronounced production fluctuation of metals had begun, resulting in part from a severe steel strike that year and in part from the winding-down of the Korean war. Investments in new plants and equipment dropped to $880 million in 1952. It was not until 1957 that private investments in domestic plant and equipment reached the peak ($1,243 million) for the decade. By 1959, however, U.S. investment in the domestic mining sector had shrunk to $987 million, and the numbers of mine failures had increased from 38 per year in 1951 to 91 per year in 1959.

Table IV C-1. U.S. private expenditures in mining industry plants and equipment, and number of mine failures for 1950-59

Year	Domestic investment (millions)	Number of mine failures
1959	$987	91
1958	941	86
1957	1,243	75
1956	1,241	42
1955	957	55
1954	975	42
1953	986	41
1952	880	42
1951	939	38
1950	446	NA

NA Not available.

2. Measures to assure supplies:

To assure a steady and equitable supply of minerals, the United States set up both domestic and international allocation systems. International trade agreements with important mineral-producing nations were negotiated, and bartering of surplus agricultural products for minerals was carried out with some nations. The national strategic stockpile became a vehicle for controlling the flow of mineral supplies, selling off excess minerals in times of shortage, and buying minerals in times of surplus. The President's Cabinet Committee on Minerals Policy, established in 1953, recommended that the national stockpile be expanded to assist in the improvement of lead and zinc prices. Thus, in 1954, the stockpile objectives were changed to include three levels of objectives (minimum, long-term, and supplemental) in order to allow a broader range of strategic minerals purchase.

The International Materials Conference (IMC) was established in 1952 for the purpose of equitable international materials allocation. The IMC had 10 members including Australia, Brazil, Canada, France, India, Italy, the United Kingdom, the United States, and two members of the Organization of American States. Four of the seven committees covered minerals: The Copper, Zinc, and Lead Committee; the Manganese, Nickel and Cobalt Committee; the Tungsten and Molybdenum Committee; and the Sulfur Committee. Each Government assumed responsibility for seeing that its allocations were not exceeded. In the United States, the Defense Materials Procurement Agency and the General Services Administration controlled the allocations, as well as controlling tax certifications and loan guarantees. Most critical minerals came under strict import and export control, as well as allocation control with some uses curtailed.

International trade agreements of significance included those with Canada, Chile, and Mexico to assure supplies in the 1950's. The "Statement of Principles for Economic Cooperation" was adopted by the United States and Canada in October 1950 and was the forerunner of the IMC for instituting international controls for distribution of scarce raw materials. In May 1952, Chile abrogated its contract with the U.S. Government, which had provided for withholding for Chilean Government disposition not over 20% of production from U.S.-owned mines in Chile. Chilean dissatisfaction with the lower prices caused by U.S. Government price controls was the cause of the break. Exports to the United States were stopped for a short time. On June 24, the Office of Price Stabilization exempted imported copper from price control, and increased prices were passed on to the domestic consumer. By August 1953, the Chilean Government had requested the U.S. Government to purchase some 180,000 tons of excess copper for the national stockpile that had accumulated as a result of oversupply and pricing problems. Copper stocks had accumulated when Chilean copper prices were higher than those of other world producers. By withholding these stocks from the market, prices were temporarily prevented from dropping. Thus, in March of 1954, a year of surplus copper supplies, the Chilean and U.S. Government reached an agreement for the purchase of 100,000 tons of copper for the U.S. national stockpile. The Mexican Trade Agreement of January 30, 1943, was reaffirmed on June 6, 1951, establishing duties in several mineral commodities, including lead and zinc.

3. Measures to stabilize the economy:

Government controls to stabilize the economy were instituted in the latter part of 1950 and included both price and supply-demand controls. Many of these were designed to prevent hoarding with the objective of selling later at higher-than-prevailing prices. Action by the Office of Defense Mobilization in 1952 to pay higher prices for foreign copper and pass the costs on to consumers gave considerable impetus to imports. Thereafter, until decontrol of domestic prices, foreign copper sold in the United States for about half again as much as domestic metal when supplies were tight. The Office of International Trade (Department of Commerce) had also severely limited the exportation of critical materials by domestic producers. By 1953, the transition from shortage to abundance was the keynote for much of the domestic nonfuels industry.

The small miner has been much involved in gold and silver mining of the United States. Hence, the monetary policies of the U.S. Treasury were to have a continuing negative effect on the numbers of small gold and silver mines in the 1950's. In addition to the world-dominating silver and gold policies of the U.S. Treasury, the silver-marketing policies of Mexico, India, and the United Kingdom were also to be major influencing factors. By holding the lion's share of silver and gold stocks and maintaining set buying prices for both ($0.90 per troy ounce for silver and $35 per ounce for gold), the U.S. Treasury effectively depressed free market prices to within narrow ranges. In the early 1950's, the London silver market was hampered by exchange regulations, India had a ban on exports and imports, and Mexico limited exports to current production. The New York free silver market, which continued to provide the basis for most international transactions for silver, had been stable for more than 2 years when the Bank of Mexico withdrew from the market in 1955. Prices rose temporarily. By 1958, when all but 40.5 million ounces of the total 410.8 million ounces of lend-lease silver sent to the Allies during World War II had been returned, the Bank of Mexico reappeared on the New York Market, and the British Government began to sell silver from the country's demonetized coins. These policies, coupled with the excessive imports of lend-lease silver returned by the Allies throughout the 1950's, served to depress the domestic silver and gold mining industries while the costs for mining were increasing. By 1959, the numbers of silver and silver-gold mines (lode and placer) had decreased to 800 from about 5,100 in 1940. In 1950, there were 647 placer gold mines, producing 611,414 troy ounces of gold; by 1959, there were 231 such mines, producing 359,000 troy ounces of gold. Silver and gold are also produced as byproducts of other metal ores, so that policies that affected the base metal industries (copper, lead, and zinc) were also to affect the supply of silver and gold.

By 1958, with continuous outflow of gold from the Treasury, agitation grew for raising the price, which the U.S. Government continued to refuse to do. The U.S. Treasury gold stocks had shrunk from about 629 million ounces (valued at $22,030 million), or about 60% of free world stocks in 1953, to about 557 million ounces (valued at $19,507 million), or about 52% of free world reserves in 1959. U.S. Treasury silver stocks amounted to about 2.8 billion ounces in 1958. The withdrawal of gold, made by purchases with acquired dollars spent in other countries, had resulted from military expenditures abroad of about $3 billion in addition to $5 billion spent in foreign investments and aid grants, compared with a net gain of only $5 billion from commercial foreign trade.

4. Postwar stabilization measures and emergency preparedness:

Many regulatory devices were discontinued in 1953, including general price controls and the International Materials Conference. With the lifting of price controls, the prices of many minerals rose; exceptions included many minerals being mined by the small miner, such as antimony, lead, zinc, cobalt, and tungsten. U.S. Government purchase contracts to domestic tungsten producers continued at higher-than-market prices. All domestic tungsten was sold to the Government at a guaranteed price of $63 per short ton unit, while the U.S. industry purchased foreign tungsten at much lower prices ($12 to $28 per ton). Tungsten mines flourished throughout the world, supported generally by U.S. Government purchases. The Export-Import Bank had also made extensive loans to develop tungsten mines in Bolivia, Peru, Spain, and Yugoslavia under long-term contracts and/or loans. Bolivia nationalized these mines in 1953 and became the principal supplier to the United States. General Services Administration purchase contracts to Bolivia were to run past those guaranteed to domestic producers, the last of which were terminated in 1956. The uncertainty of future U.S. Government support brought 7 years of expansion in the domestic tungsten mining industry to an end in 1957. From a domestic production of 2.9 million pounds of contained tungsten in 1949, production had increased to a peak of 15.8 million pounds in 1955 and 1956. When the Government stopped purchasing, supply far exceeded demand; mines in the United States were capable of producing twice the tungsten required by industry. Tungsten prices and consumption both rose in 1959, reaching an equilibrium more nearly related to the costs of production, but the increase came too late for survival of many of the domestic tungsten mines, which numbered 700 in 1954 and 2 in 1958. The short-term production goals for cobalt and tungsten were achieved through Government stimulation, and were exceeded in the case of tungsten, but the long-term goal of a sufficient domestic source and a healthy mining industry was not achieved. Calera Mining Co., the largest domestic producer of cobalt, closed its mine and refinery in 1959 after completing its Government contract. Domestic mines had furnished 36% of U.S. cobalt requirements in 1957, the highest year of production.

In 1953, a number of small antimony mines closed because of reduced prices of foreign producers, which were much below domestic levels. On May 15, 1953, antimony was removed from the list of minerals eligible for DMEA exploration benefits. There were eight antimony mines in the United States in 1950 and none in 1959; the only primary domestic source continued to be as a byproduct of base metal mining and refining by the Sunshine Mining Co. in Kellogg, Idaho. Deliveries of imported antimony, bartered for agricultural products by the Commodity Credit Corporation, constituted a major portion of U.S. imports in 1954. Many of the small lead-zinc producers also closed at midyear 1952 because of low prices. Imports of lead during 1952 were more than double those of 1951 because of prevailing lower foreign prices. The Office of Price Stabilization revoked the price ceiling controls in 1953 because of the abundant supplies. Free trading for lead was established on the LME for the first time in 13 years, and lead futures, suspended in 1950, were resumed on the New York Commodity exchange. The Government continued to buy some lead and zinc under contract from foreign countries for the strategic stockpile under the extended emergency preparedness program and resumed purchase of domestic lead and zinc for the long-range stockpile in 1954, but this action was too late to help some smaller mines survive. Thirteen lead smelters were in operation in 1951, 11 in 1954, and 12 in 1959.

Postwar mineral supply stabilization efforts included a plan presented by the Secretary of the Interior in 1958 that was designed to stabilize production of lead, zinc, fluorspar, and tungsten mines by establishing a system of stabilization payments to sustain constant receipts from mined ore. In addition, a 1-year copper purchase plan was suggested for use during periods of oversupply. Many changes were made in the plan as proposed as it passed through Senate and House Committees, and it was defeated by the House in August. After rejection of the plan, the President imposed import quotas, based upon 80% of a 5-year (1953-57) period. These quotas, once instituted, prompted an immediate improvement in production and prices by yearend. The import quotas continued without revision throughout 1959. No Government purchases of lead were made in 1959 since the procurement program had been terminated at the end of 1958, and lead had been deleted from the barter program.

In 1959, the list of minerals under the barter program was reduced from 39 early in the year to 14 by December. All goals in the metals and minerals expansion tax amortization program were closed in 1959, including the goal for uranium, which had been suspended by the Atomic Energy Commission. Except for some aluminum and iron ore projects, all metals and minerals facilities expanded through the 5-year tax write-off program were installed by yearend 1959. Activities in general were at a low level under the Defense Mobilization program. The Tariff Commission rejected applications by the fluorspar, tungsten, and cobalt industries for relief under the national security clause.

As a result of the downward revisions of the stockpile objectives in 1958, from the previous 5-year requirements to a 3-year emergency period, many commodities exceeded the new "maximum" objectives, and the stockpile situation changed from one of acquisition to one of disposal. The only new purchase contracts under the Defense Production Act in 1958 were for domestic and foreign mica. Plans for disposal were worked out, and in September 1959 sales were sanctioned by Congress for diamond gems, platinum-group metals, and zircon. Efforts to sell surplus copper were not successful. In December 1959, a new Defense Mobilization order limited the maximum objectives, in event of nuclear attack, to not less than 6 months. This was to make most stockpile inventories sufficient to meet maximum objectives in effect at yearend 1959.

IV. C-4

U.S. MINERALS POLICY IN THE 1960's

The 1960's can be characterized as a period of a continuously expanding economy influenced by the Vietnam War with inflation starting to increase in 1966; the Federal Government attempted to restrain inflation through tax and monetary policies and wage-price guidelines.

During this period several governmental acts, programs, and actions were designed to specifically aid the minerals industry, stabilize prices, and assure adequate supplies. Other programs indirectly affected the minerals industry. A list of some of the more important acts, programs, and actions follows:

The Defense Production Act
Defense Minerals Exploration Administration
Office of Minerals Exploration Program
Strategic Stockpile Activities
Lead and Zinc Mining Stabilization Program
Vietnam War
Import and Export Quotas and Controls
Wage Price Guidelines
Commodity Exchange Actions
Monetary Policy -- Silver
Monetary Policy -- Gold
Change in Depreciation Rates
Investment Tax Credits Reinstated and Canceled
Heavy Metals Program
Domestic Copper Production Expansion Program
Ten-Percent Tax Surcharge

1. Measures to increase supplies:

The Defense Production Act of 1950 was extended through June 1966. The Office of Minerals Exploration (OME) was continued with modification. This program replaced the Defense Minerals Exploration Administration (DMEA). By 1960 the DMEA program had been credited with 392 certified discoveries out of 1,159 contracts. This program had cost approximately $31 million and was responsible for locating recoverable ore reserves valued at nearly $1 billion. The OME program was designed to aid small miners and was an important factor in maintaining adequate supplies of vital minerals. In 1961 gold and silver were added to the OME program, and in 1966 lead and zinc were removed. In 1964 the amount of Government participation for silver exploration was increased from 50% to 75% and in 1967 the increased participation included gold and several other minerals that were in short supply.

In 1962 the Lead and Zinc Mining Stabilization Program was enacted. This program was designed to aid the small producer by assuring that the payment per pound for lead would be 75% of the difference between 14.5 cents and the average monthly market price for common lead at New York, for the month in which the sale occurred, and that the payment per pound for zinc would be 55% of the difference between 14.5 cents and the average monthly market price for Prime

Western Zinc at East St. Louis, Ill., for the month in which the sale occurred. In 1965 this program was expanded to all producers.

In 1965 the Coinage Act was passed. This act reduced the amount of silver in half-dollar coins, provided for silverless dimes and quarters, and prohibited the minting of silver dollars for 5 years. The Secretary of the Treasury was authorized to prohibit export or melting of any U.S. coins. In 1968 a law enacted in 1967 terminated the redemption of silver certificates, and the 165-million-ounce reserve supply of silver was transferred to the strategic stockpile. These actions were taken to reduce the drain of silver.

In 1965 import quotas on lead and zinc were canceled. Export controls were placed on copper in 1967 and then canceled in 1968.

In 1967 the first contract for production of domestic copper, silver, and molybdenum was executed by the General Services Administration (GSA) under a program authorized by the President. Under this program the GSA advanced money against future deliveries at a set price and also guaranteed a private loan at 70% of the principal.

Investment in the mining industry remained fairly constant until the 7% investment tax credit and accelerated amortization of depreciable equipment and machinery were announced by the Treasury Department in 1962. The investment tax credit was apparently canceled in 1966, reinstated in 1967, and canceled again in 1969.

Table IV C-2. U.S. private expenditures in mining industry plants and equipment and number of mine failures for 1960-69

Year	Domestic investment (millions)	Foreign investment (millions)	Number of mine failures
1969..............	$1,860	$1,132	34
1968..............	1,630	1,035	57
1967..............	1,650	920	71
1966..............	1,470	807	73
1965..............	1,300	645	84
1964..............	1,190	420	70
1963..............	1,040	398	84
1962..............	1,080	371	85
1961..............	980	312	103
1960..............	990	NA	98

NA Not available.

2. Measure to stabilize economy:

Some policy decisions had a negative impact on price stability. These decisions, however, were necessary to reduce the drain of silver and gold. In 1961, a Presidental order suspended Treasury sales of silver to domestic consumers. This action brought on a sharp advance in prices and ended a 3-year period of price stability. In 1963 the tax on transfer of interest in silver bullion was repealed, opening the way for trading in silver futures. Legislation was enacted for the eventual elimination of silver backing for U.S. currency. The price increases probably contributed to the increased production that followed.

In early 1965 the Government, in an effort to relieve domestic shortages of copper, released 20,000 tons from the stockpile and authorized an additional release of 100,000 tons in April. In November the Government announced a four-point program to reduce inflationary pressure on the price of copper that might impair the defense effort in Vietnam. The program called for release of 200,000 tons from the stockpile, control of exports of copper and copper scrap, legislation to suspend the 1.7-cent-per-pound import duty, and imposition of higher margin requirements on copper trading by directors of the Commodity Exchange in New York.

In 1966 a booming economy with rising consumer demand and the pressure on supply for the Vietnam War strained production capacity in many mineral industries. The Government initiated the wage-price guidelines and used the strategic materials stockpile in an effort to maintain price stability and assure essential supplies of scarce resources. Production levels for copper, silver, lead, zinc, gold, and antimony remained stable for the first 6 months of 1967 with the wage-price guidelines. A major copper strike in the last 6 months of the year disrupted production of copper and byproduct metals.

In 1968 sales of gold were terminated in the London Market by the Central Banks of the Seven Nation International Gold Pool, and a two-tier price system was established. The U.S. enacted legislation removing the 25% gold backing of Federal Reserve notes, effectively severing the last link between the Nation's gold reserve and the amount of currency that could be issued. In June 1968 legislation ratifying an amendment to the International Monetary Fund Articles of Agreement, authorizing U.S. participation in the Special Drawing Rights (SDR) plan, was enacted. The SDR's are designed to supplement gold in international monetary transactions. The new law authorized the Secretary of the Treasury to issue SDR's for financing exchange-stabilization operations. The $35-per-ounce fixed price of gold adversely affected gold production through the decade.

In 1962 the planning base for the national (strategic) stockpile was changed from 5 years to 3 years. This change resulted in excess material in the stockpile. In 1963 the Office of Emergency Planning began work on developing a long-range disposal program. The objectives set in 1962-63 reduced the requirements for copper from 1 million to 0.75 million short tons, lead from 236,000 short tons to zero, and zinc from 178,000 short tons to zero. Excesses were also declared in cobalt, molybdenum, and tungsten. In 1965 silver was added to the stockpile objectives. The proposal for large sales of tungsten from the stockpile in 1964 kept the price down until 1966. The low price contributed to the closing of one mine. In 1969 the GSA created a stable domestic price for tungsten of $43 per short-ton unit by sales from the stockpile.

3. Mineral Summaries

Antimony was largely a byproduct metal in the 1960's, with domestic production essentially dependent on silver-lead ore output.

Cobalt output during the 1960's was chiefly limited to that recovered from the processing of cobaltous pyrite concentrates produced as a byproduct of iron ore mining in Pennsylvania. A small amount was also recovered as a minor byproduct from one zinc plant. Total output was never substantial (about 6% to 10% of annual demand) and was dependent basically on the level of iron ore mining activity. Domestic demand was met primarily by imports, although shipments from Government stockpile inventories became significant from 1967 to 1969.

Copper production generally increased throughout the 1960's. A rather stable price held production below potential output until 1964, when the Vietnam War effort and increased domestic demand created price and production increases. This trend continued through 1969 except for a period of labor strikes in 1967. OME continued to offer up to 75% Government cost participation for copper exploration and had several active contracts.

Gold output remained stable through 1964 but gained substantially in 1965 in Utah and Nevada as new facilities were opened. The United States became a net importer in 1969 for the first time since 1960. Production might have been higher throughout the sixties if there had not been a fixed price of $35 per ounce. With the adoption of the two-tier gold price in 1968, the average price and output increased. There was a serious decline in the number of placer mines in the United States during the sixties, from 265 in 1960 to 66 in 1969.

Lead production increased overall from 1960 to 1969. A strike in Missouri operations in 1962, which carried over into 1963, dropped output sharply. There was a 40% increase in production in 1969 over 1968 as major new mine facilities started up. Consumption had reached record levels by 1969.

Molybdenum production increased from 68 million pounds in 1960 to nearly 100 million pounds in 1969. About two-thirds of domestic output was derived from primary ore, chiefly the Climax Mine in Colorado. Most of the remainder was recovered as a byproduct of copper ore mining in Arizona, Nevada, New Mexico, and Utah; a tungsten mine in California was an additional minor source. Output expanded in order to satisfy growing domestic and world demand, as the United States was, and continues to be, the world's major producer and principal exporter to other industrialized nations. Two medium-sized primary ore mines were brought onstream in the mid-1960's, and increased copper-byproduct output was realized. Beginning in 1963, releases from the Government defense stockpile also contributed to supplies.

Domestic mine production and imports of silver showed an overall increase during this period, although exports in 1968-69 exceeded imports by a substantial margin. Average price increased, with base metal ores accounting for about 60% of new metal production. Relatively few of the mines depended on silver as the principal product. Coinage use, which had gone from 56 million ounces in 1960 to 320 million in 1965, dropped to 19 million by 1969 as a result of the Coinage Act. Industry stocks replaced Government stocks as major silver holdings, with the latter stocks being reduced from about 2 billion ounces in 1960 to 190 million in 1969, and industry stocks going from less than 1 million to approximately 200 million in the same period.

Tungsten output was fairly stable in the 1960's. Although demand was off early in the decade, resulting in low prices and reduction of operating mines, activity increased during the second half. The world market became one of tight supply, with rapidly increasing prices. Unrestricted release from the Government stockpiles at fixed prices helped alleviate the withdrawal of mainland China imports, with 1.5 million pounds being sold in 1966 from the DPA inventory. In 1969 stockpile releases continued to have a stabilizing effect, but demand had increased to an apparent 20 million pounds and some 40 mines reported production and/or shipments.

Zinc production and prices increased steadily until 1966, when the import quotas were canceled. The higher imports of foreign zinc and sales from the Government stockpiles resulted in a decline in production and prices until 1969. The strike in 1967 carried over into 1968, which also added to the production decline.

4. The Significance of Strikes

Strikes were of major significance to the health of the mining industry during the 1960's and had as much adverse impact as some government policy, and many times offset the positive aspects of government action. A strike in 1959 carried over to 1960, reducing the output of copper, silver, lead, zinc, and gold. In addition to the negative impact of the 1959 strike on silver, lead, and zinc, another strike occurred in 1960 in Idaho that further reduced output. Another strike in Idaho in 1962 reduced silver production, and a strike in Missouri reduced lead production. Again Idaho's silver production was hurt by a strike in 1963. In 1964 strikes caused some loss of production of copper and gold in Arizona and Utah; lead and zinc were also affected by the Utah strikes. Idaho's silver production was again hampered by strikes in 1964. In 1967 over 90% of the copper-producing industry was on strike for the last 6 months of the year. This strike affected copper, lead, zinc, silver, gold, antimony and molybdenum. Another strike in Idaho lasted for 5½ months in 1968, severely reducing the silver production of the State.

III. I. 5.

U.S. MINERAL POLICY IN THE 1970's

The 9-year-long Vietnam War lasted until 1973, and the inflation fueled by the war and the "Great Society" Government spending of the 1960's continued to be a problem through the seventies, exacerbated by the Arab oil embargo and OPEC pricing policies. The decade of the 1970's was one of general economic instability, environmental concerns, and extensive domestic and foreign governmental manipulations. In the United States, a rising concern with the environment, safety in the workplace, and wilderness conservation was reflected in a series of governmental actions that started late in the 1960's and reached fruition in this decade. These developments, coupled with rising fuel and operating costs, labor strikes, manipulations of the national strategic stockpile, and general governmental economic policy actions to combat inflation and the deteriorating value of the dollar, were to a have negative impact on most of the mining industry. Foreign mineral policies also were to be felt more strongly than in any period before, and included a general policy of increasing raw material processing at the source, nationalization of U.S. foreign investments, the formation of mineral associations and cartels, and excessive pricing of petroleum by OPEC nations. LME pricing policies and changing international monetary policies also affected the mining industry.

As a consequence, U.S. Government mineral policy during the 1970's was designed generally to (1) promote market and price stability, (2) solve environmental, health, and conservation problems, (3) provide for emergency preparedness, and (4) increase mineral supplies. Except for exploration loans, and some spinoffs from money spent on U.S. Government technology research, no policy was put forth to assist the small miner. Some policy initiatives, in fact, were to inhibit the growth of any mining in certain areas. Although not planned specifically to help the small gold miner, the change that took place in the U.S. Government's monetary policy, which raised the price of gold, was to be one of the more positive mineral policies undertaken.

1. Measures to promote market and price stability:

Inflation continued into the early 1970's from the overheated economy of the Vietnam war, while industrial production slackened and business investment in plant and equipment weakened. Both monetary and fiscal Government measures were applied to stimulate noninflationary growth and market and price stability but with only modest success. The oil embargo of 1973 and later cartel action of the OPEC nations to raise the price of petroleum added fuel to the inflation fire, just as Phase IV of the Economic Act of 1971 was phasing out tight monetary and price controls and phasing in a new international monetary scheme with the IMF to release the dollar from its gold backing.

The New Economic Policy (NEP) was announced by the President on August 15, 1971, and was to follow a four-phase implementation schedule. Phase I included an immediate 90-day freeze on wages, prices (including those of metals), and rents, a 10% surcharge on imports, a proposed tax credit for new investment in equipment to create jobs and productivity, an increase in personal tax exemptions, a 10% cut in foreign economic aid, and suspension of the convertibility of the dollar into gold. Three laws dealing with import regulations for selected minerals were also passed. All of these measures were to only temporarily slow the rate of inflation and ease international pressures on the dollar. Phase II was in effect during 1972. Designed to be a transition between the freeze of Phase I and less stringent controls, Phase II created an environment more favorable to expansion. By 1973, when Phase IV was in effect, inflation was again becoming severe, with prices increasing more rapidly than in any period since the Korean war.

The energy crisis created by the Arab oil embargo became severe in late 1973, leading to the introduction of a number of fuel conservation and allocation programs by the Government. By 1974, all mineral industries, especially the high-energy-consuming smelters and refineries, were feeling the effects of expanding energy costs. Prices of mineral energy commodities increased substantially during 1974 as shown by table IV C-3.

Table IV C-3. Comparative mineral energy resource prices
(U.S. dollars, average prices)

Year	Coal (bituminous, per metric ton)	Crude petroleum (per barrel)	Natural gas (cents per 1,000 cubic feet)
1976..........	54.90	8.14	NA
1975..........	52.63	7.56	115.0
1974..........	34.20	6.74	88.8
1973..........	19.77	3.89	66.5
1972..........	17.67	3.39	62.1
1971..........	15.32	3.39	57.7
1970..........	12.28	3.18	53.6
1969..........	10.75	3.09	51.5
1968..........	10.58	2.94	50.4

NA Not available.

U.S. monetary schemes to stem the flow of gold from U.S. Treasury stocks and release the U.S. dollar from its international gold convertibility were also to affect the mining industry. Two of the most important events affecting the gold industry in 1970 were the South African-International Monetary Fund agreement, which placed a $35 per troy ounce floor on free-market gold, and the introduction and use by the IMF of the special drawing rights (SDR) as a new international asset. In the first year of operation, 37 IMF members exchanged $472 million in SDR's (paper gold). U.S. gold reserves declined by 24.7 million ounces to a total of 291.6 million ounces in 1971, while IMF reserves and those of central banks and other free world governments rose by 11.2 million and 11.6 million troy ounces, respectively. In August 1971, the U.S. suspended the exchange of gold for dollars in official transactions by Presidential order. Free market gold reached a record price of $126.45 per troy ounce in 1973, and the U.S. Government ceilings imposed as part of the NEP price controls prevented the price from going even higher. In November 1973, the two-tier gold-pricing system was finally terminated by the seven nations that had initiated it in March 1968. The United States is the only holder of large gold reserves to still value them at the low official price of $42.22 per ounce; most other nations value their gold reserves at market-related prices. Gold reached $850 per ounce in January, 1980.

The unit SDR of the IMF was equivalent initially to 0.888671 gram of fine gold by definition, but in July 1974 the IMF adopted an SDR valuation based on the weighted average of exchange rates for the currencies of 16 member countries. Public Law 93-373 was enacted in 1974, removing restrictions on U.S. citizens for buying, holding, and selling gold.

The rising price of gold in 1978-79 stimulated the search for gold in the Western States. The total number of gold mines was 86 in 1978. There were about three dozen substantial deposits being explored, and about half of these entered the development or production stage during 1978-79. However, the number of placer deposits, accounting for about 1 to 2 percent of total U.S. gold production, decreased during the decade. In 1969, there were 66 placer gold mines producing 25,000 troy ounces of gold, and by 1979, there were only 23 placer mines producing 7,000 troy ounces of gold. Although the rising prices were providing a stimulus, other Government laws and regulations were to serve as a dampener to increased numbers of small gold mines.

Sales through the General Services Administration's tungsten disposal program effectively stabilized the domestic price of tungsten in the early 1970's. In 1970, this price was about $49 per short ton unit (stu). The European price at this time averaged about $70 per stu. The GSA sold substantial amounts from the strategic stockpile to domestic users and to Western and Eastern European countries to fill the supply gap left by the withdrawal from the market of the Chinese. Domestic mine production fell in 1971 as the two-phase GSA sales program continued, creating an oversupply condition while the general market was responding to a general slump in the U.S. economy. Stockpile sales in 1971 were 7.7 million pounds of tungsten at an average price of $55.3 per stu. Although there were no Government stockpile sales during the first half of 1973, the quoted domestic price of tungsten concentrate during this period continued to be $55 per stu, reflecting the GSA shelf price. Tungsten concentrate was purchased from GSA during the last quarter of 1973 at prices, ex-duty, ranging from $40.65 to $48.32 per stu. After reevaluating the tungsten market, the GSA ceased the two-phase sales and initiated a monthly sealed-bid offering in 1973, which continued as its policy for the remainder of the period until sales ceased with the change in stockpile goals in 1976. By 1978, the number of tungsten mines reporting production had reached 65, up from the 47 reporting in 1970; 51 of the mines in 1978 produced less than 1,000 tons of crude ore per year. This improvement was in response to the increased domestic consumption from 1975 to 1979 and increased prices that reached $133.13 per short ton unit in 1979. Because domestic production could not keep pace with demand, however, significant increases in tungsten imports also occurred, particularly in 1978 and 1979.

Price controls and stockpile sales were also used to stabilize the supply of copper. Price controls were instituted in 1971, and the domestic price was restricted to 68 cents per pound until the removal of controls in 1974. The price immediately rose to 85 cents by June 1974; then, reflecting changing market conditions influenced by a worldwide recession, the price readjusted to 72 cents by yearend. In March 1973, the copper stockpile objective was reduced to zero and a law authorizing the sale of 251,000 tons of copper was passed. GSA also transferred 85,000 tons of excess metal to the Bureau of the Mint. GSA continued to make stockpile releases, and all of the copper, except for 489 tons, was disposed of by yearend 1974. Industrial stocks during 1974 increased as a result of the excesses created by mining production, net imports, and

Government stockpile releases. There were 105 copper-producing mines in 1970, 61 in 1975, and only 43 in 1980. Production had also decreased from a high of 1,720,000 short tons in 1970 to 1,168,000 short tons in 1980. The United States' import reliance during this period had increased from 4% in 1970 to 14% in 1980 as imports of copper had steadily increased.

2. Measures to address environmental, health, and conservation concerns:

The National Environment Policy Act was implemented in 1969; this was followed in 1970 by the Clean Air Amendments, which established air quality standards for automobiles and fuels. In the next several years, many laws were passed (see appendix for lists and descriptions of legislation) by Congress addressing subjects of concern to the minerals industry, including the environment, endangered species, preservation of historical sites, reclamation of mining lands, energy, water quality, public land withdrawals, special leasing acts and mining laws, black-lung disease benefits, and consumer and labor safety. By 1973, the mining industry was faced with many problems brought about by these new constraints and by increasing labor, fuel, and other operating costs.

Table IV C-4. Price index of principal iron and copper metal mining expenses (1957 to 1959 = 100)

Year	Labor	Supplies	Fuel	Electrical	Total
1977..........	218	202	302	233	218
1976..........	196	188	266	208	198
1975..........	190	177	245	193	189
1974..........	172	157	208	163	168
1973..........	135	128	146	129	133
1972..........	126	120	119	122	123
1971..........	114.0	115.7	114.2	113.6	114.6
1970..........	122	118	110	106	119
1969..........	116	113	105	103	114
1968..........	113	109	102	102	110

Smelters, in particular, were to feel the effects of environmental requirements under the Clear Air and Water Quality Acts (see detailed discussion, this report), which required extensive shutdown periods not only for making the technical improvements required but also during adverse weather conditions, and were expensive, adding to the other rising costs of production. Domestic zinc production (by eight primary plants) in 1971 was made up of 48% domestic ores, 43% foreign ores, and 9% scrap. By 1977, this ratio (at six primary plants) was 71% from domestic ore, 19% from foreign ores, and 19% from scrap. By 1978, domestic production of zinc was at the lowest level since 1932 as both mine and metal production declined, with mines closing and smelters cutting back production to reduce stocks. The zinc smelter at Monaca, Pa., the largest in the United States and the fourth largest in the world closed, for 1 year because it became uneconomical. With a poor market and expected costly renovations to comply with environmental regulations, the plant, which was old and labor intensive, had lost money for 2 years and could not afford to keep open. In 1980, the plant reopened at 25% of the original capacity.

Copper production was also curtailed throughout the 1970's because of periodic shutdowns to comply with environmental regulations and make extensive technical improvements as well as for sometimes extended periods of labor strikes. In 1971, ASARCO estimated capital expenditures for an improvement program to meet smelter emission standards for the company's three smelters at $50 million and asked supplying mines to pay a special surcharge of 1 to 1½ cents per pound to help finance the program. Magma Copper permanently closed the Superior, Ariz. smelter in July 1971 and all concentrates were treated at the San Manuel smelter, where Magma was constructing a modified environmental control system. The San Manuel smelter operations also were adversely affected during the fourth quarter of 1976 and the first quarter of 1977 by an unusually high number of intermittent stoppages required for air pollution control during atmospheric inversions. Mining and milling at the Kennecott Copper McGill, Nev., operations were suspended early in 1976 because of high operating costs and closure of an associated smelter pending resolution of disagreements on required pollution control facilities; in 1977, the company reopened the smelter after a 5-month closure. In 1978 and 1979, with stronger copper prices, copper companies continued to make expensive modifications and additions to their smelters to comply with required environmental regulations. Several smelters were expected to close in the mid-1980's, however, because the additional capital costs had been determined not to be economically justified. Anaconda closed its Montana smelter and refinery in 1980 and now ships concentrates to a consortium of Japanese smelters as part of a continuing retrenchment in face of mounting losses.

During the 1970's the U.S. contribution to world mine and smelter production decreased for many commodities, as table IV C-5 illustrates.

Table IV C-5. U.S. percent of selected world mineral production

	1971	1973	1974	1976	1977
Copper:					
Mine............	22.8	22.0	20.0	19.6	18.0
Smelter.........	22.3	22.0	19.0	19.0	17.0
Lead:					
Mine............	15.4	16.0	17.0	16.5	16.0
Smelter.........	18.6	18.0	18.0	17.0	16.0
Zinc:					
Mine............	8.0	8.0	8.0	7.5	7.0
Smelter.........	16.7	10.0	9.0	8.0	7.0
Silver............	14.1	12.0	11.0	11.3	12.0
Tungsten:					
concentrate.....	8.5	9.0	9.0	6.3	6.0

3. Measures to provide for emergency preparedness:

As in the previous 20 years, the Defense Production Act of 1950, as amended, was to serve as the basic instrument for many strategic stockpile mineral policy actions. This act, in its amended form, permitted Governmental action:

> To establish a system of priorities and allocations for materials and facilities, authorize the requisitioning thereof, provide financial assistance for expansion of productive capacity and supply, provide for price and wage stabilization, provide for the settlement of labor disputes, strengthen controls over credit, and by these measures facilitate the production of goods and services necessary for the national security, and for other purposes.

During the 1960's and early 1970's, the assumptions regarding military and industrial emergency preparedness were often modified. For example, stockpile goals were reduced after assumptions about the length of a potential U.S. war emergency were reduced from 5 years to 3 years to 1 year, based on the belief that a nuclear war would be swift and decisive and eliminate any protracted conventional conflict. As a result, excesses were created in every commodity, and billions in stockpile sales were used to reduce budget deficits created by the Vietnam War and other Government programs and as a mechanism to stabilize market supply and prices.

In the fall of 1976, a new stockpile policy restored many of the original goals on a 3-year contingency basis, but it was too late to save the materials already sold. The most valuable commodities especially had been depleted. For example, in 1970, of an estimated $2.7 billion in materials considered as excess of stockpile needs, only 13 commodities accounted for over 76% of the market value. Sales commitments for 1970 totaled $187.3 million. The biggest sales items valuewise were silver, tungsten, and tin. Sales commitments in 1971 totaled $235 million, of which copper ($130 million), nickel ($28.4 million), and Surinam bauxite ($26 million) formed major components. Sales commitments in 1972 totaled $289 million, with zinc ($68.9 million) and nickel ($119.6 million) accounting for the major portion of the revenues.

The Strategic and Critical Materials Stockpile Revision Act of 1979 created a national defense stockpile by combining the three previous stockpiles and limited stockpile materials for use only for the common defense of the United States. The act prohibited stockpile sales to control or influence commodity prices or to produce receipts for budgetary purposes. The act also provided for the stabilization of stockpile goals and for a more efficient operation and management of the stockpile. Some materials, such as silver, were revalued under the basis of the new policy and were now considered to be in excess of stockpile requirements. Thus stockpile sales of certain commodities were to continue in the 1980's, and stockpile purchases of commodities such as cobalt were planned.

4. Measures to increase mineral supplies:

Measures to increase mineral supplies included tax incentives of the NEP, exploration assistance under the Office of Minerals Exploration, the Heavy Metals Program of the Department of the Interior, and various import and export controls. Although limited in application, all were to meet with some measure of success.

The tax incentives and import restrictions of the 1971 Economic Stabilization Act prompted renewed investment in domestic plant and equipment, which had increased by only $30 million between 1969 and 1970 (table IV C-6). After 1971, the combination of U.S. Government policy, which limited foreign aid and changed foreign-earned income tax laws (Tax Reduction Act of 1975), and the negative investment attitudes created by rampant foreign nationalizations served to reverse the trend of U.S. private investments in foreign mining. Yearly expenditure on foreign plant and equipment by U.S.-owned affiliates was down to $808 million by 1977, from a high point of $1,465 million in 1971. The number of recorded mining industry failures in the United States also declined, coincident to increased expenditures, until 1975. Then, after the energy crises of 1973 and 1974 and renewed inflation, the number of mining industry failures began once again to rise, reaching 30 in 1977 from a low point of 9 in 1974. It is interesting to note that while U.S. foreign investments have been decreasing, foreign investment in the United States has been steadily increasing. A doubling of foreign investment in the United States occurred between 1972 and 1975.

Table IV C-5. U.S. private expenditures in the mining industry, plants and equipment, and the value of foreign investments in the United States (millions of dollars)

Year	U.S. domestic expenditures		U.S. foreign expenditures		Foreign investment in the United States
	Increase	Total	Increase (Decrease)	Total	
1977........	500	4,500	(108)	808	NA
1976........	210	4,000	(267)	916	NA
1975........	610	3,790	93	1,173	26,740
1974........	420	3,180	(21)	1,080	22,421
1973........	340	2,760	(66)	1,101	18,284
1972........	260	2,420	(298)	1,167	14,363
1971........	270	2,160	78	1,465	13,655
1970........	30	1,890	255	1,387	13,270
1969........	418	1,860	NA	1,132	11,818

NA Not available.

The Office of Minerals Exploration (OME) continued to operate in the 1970's but without sufficient funds was unable to undertake an expansive program. A few contracts were active for gold and silver; OME received 10 applications involving silver in 1971 and negotiated 2 contracts totaling $86,300 in Colorado and Elko County, Nev. Copper also continued to be eligible for OME assistance, but no contracts were undertaken in the 1970's. Lead and zinc were removed from the list of eligibles in the 1960's.

On July 1, 1970, the Heavy Metals Program of the Department of the Interior, which was started in mid-1966, was terminated. Conducted jointly by the U.S. Geological Survey and the Bureau of Mines, this comprehensive program to stimulate domestic gold production examined most aspects of the gold cycle from exploration through recycling of scrap material. The first commercial benefits resulting from the program's exploration and research activities were achieved with the opening of the Nevada Cortez gold mine in 1969 and the early 1971 startup of the Carlin Mill addition, using a Bureau of Mines process to treat carbonaceous gold ores.

The domestic mineral industry was to receive scant consideration in the face of foreign supply competition. Import and export controls and tariffs were applied at various times throughout the decade, but the general trend was toward less of a protectionist posture. In the early 1970's, an expansion of world copper productive capacity resulted in an oversupply and price reductions. The improved supply situation led to the removal of export controls that had been in place since September 1965. An attempt was also made during the year to enact a restrictive trade bill, which would have been a sudden switch to protectionism by the United States, but the bill failed to pass Congress. The 10% surcharge on zinc, tungsten, and other dutiable imports that was imposed by the Government on August 16, 1971, was removed by Presidential proclamation on December 20, 1971. Imports of zinc in ores for consumption were 36% higher in 1971 because of a decision to exempt all warehouses entries prior to August 16 from the surtax if withdrawn before October 1, 1971. In September, 204,445 tons of zinc ore was withdrawn from bonded warehouses to escape the surcharge.

As the final part of the 5-year program of tariff reductions agreed upon at the "Kennedy round" of tariff negotiations, the U.S. import duties on all forms of tungsten from non-Communist countries were further reduced, effective January 1, 1972. The rates applicable to Communist bloc countries remained unchanged at 50 cents per pound of contained tungsten. Because of the difference in duty rates, imports of tungsten concentrates originating from the People's Republic of China, which was the world's major tungsten-producing country, did not come directly into the United States in the early 1970's. With the passage of Generalized System of Preferences (GSP) of the Trade Act of 1974, certain countries, including Bolivia, Brazil, Peru, and Thailand, were exempted from import duties. The program was continued throughout the decade. In 1977, 7% of U.S. tungsten concentrate imports came from the People's Republic of China; in 1981, this was up to 18%, reflecting an easing of trade restrictions between the two countries.

Various concerned Government study groups continued to make recommendations during the decade, but little positive action resulted from them. A number of factors were identified in 1970 by a Cabinet Committee on Economic Policy as obstacles to domestic copper production expansion. These included a decline in ore grade without compensating advances in technology, ecological constraints, price uncertainties, and an absence of a clearly defined national minerals policy. A number of alternatives were given to increase supplies and to reduce the inequities and economic inefficiencies that had occurred under the two-tier pricing system. In an effort to assign government responsibilities for mineral policy development, the Congress passed first the Minerals Policy Act of 1970 and later, the Minerals Policy Act of 1980. Mineral industry reporting, research, and policy responsibilities were spelled out under these acts. The goal of both acts was to promote an economically sound minerals industry.

The following tables showing the 1940-1980 production trends and U.S. dependence on foreign sources for antimony, cobalt, copper, lead, molybdenum, silver, tungsten, and zinc were prepared by the Bureau of Mines for the House Armed Services Subcommittee on Strategic and Critical Materials on December 31, 1981. Other salient statistics affecting the eight commodities also are shown.

Table IV. C -- 7

ANTIMONY

1980 Dependence on Foreign Sources: 48%
Percent of imports: Republic of South Africa 35%, Bolivia 26%, Mainland China 14%, Mexico 8%

unit of measure: short tons

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	18,000	21,000	44,000	25,500	40,700	0	36,000
inventory	2,352	18,284	30,306	49,491	46,746	40,714	40,729
deficit or surplus	-15,648	-2,716	-13,694	+23,991	+6,046	+40,714	+4,729
United States							
Mine Production	494	2,497	635	845	1,130	886	343
Number of producing mines	Unavail.	8	Unavail.	11	10	2	2
Old Scrap recovery	11,176	18,771	17,447	21,710	18,615	16,020	17,198
Apparent consumption	24,680	33,389	31,666	37,214	35,348	32,009	33,817
Imports	16,018	14,391	14,515	14,879	18,654	18,706	17,996
Import reliance (%)	53	36	43	39	44	47	48
Stocks	3,417	8,189	7,163	8,622	8,847	14,957	8,411
Ore reserves (metal content)	Unavail.	100,000	110,000	110,000	110,000	100,000	120,000
Production by area							
China	9,335	6,600	16,500	16,500	13,000	13,000	11,000
Japan	--	177	458	63	7	--	--
South Africa	139	9,161	13,538	13,901	19,147	17,553	14,410
U.S.S.R.	--	--	6,300	6,800	7,400	8,300	9,000
North America (includes US)	1,648	2,819	1,461	1,496	1,493	2,906	2,703
Latin America (includes Mexico)	25,352	17,217	11,556	16,245	20,989	17,960	22,287
Western Europe	6,463	5,796	3,812	4,018	5,388	4,405	3,900
Eastern Europe	1,217	2,200	1,800	1,300	660	770	330
Other Africa	977	2,552	1,344	2,696	2,074	1,556	2,460
Other Asia	196	1,816	1,811	5,380	5,954	8,233	6,255
Australia & Oceania	346	250	172	1,057	1,012	2,431	1,720
World Production total	45,673	48,588	58,752	69,456	77,124	77,114	74,065
World reserves (metal content)	Unavail.	5,500,000	4,000,000	4,000,000	4,000,000	4,565,000	4,800,000
Number of producing countries	22	24	22	25	24	27	24

Table IV. C -- 8

COBALT

1980 Dependence on Foreign Sources: 93%
Percent of imports: Zaire 38%, Zambia 14%, Japan 8%, Belgium-Luxembourg 8%, Norway 7%, Other 25%

unit of measure: thousand pounds

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	Unavail.	Unavail.	Unavail.	42,000	38,200	11,945	85,400
inventory	"	13,975	100,394	102,200	79,127	47,649	40,802
deficit or surplus	"	Unavail.	Unavail.	+60,200	+40,927	+35,704	-44,598
United States							
Mine Production	134	809	2,247	1,186	697	0	0
Number of producing mines	4/5	2	3	2	1	0	0
Old Scrap recovery	Unavail.	126	240	87	69	342	1,183
Apparent consumption	4,300	10,000	9,170	14,384	16,262	14,056	17,053
Imports	4,200	9,095	12,170	15,408	12,417	6,608	16,302
Import reliance (%)	98	90	76	91	95	98	93
Stocks	Unavail.	1,174	755	3,000	5,733	6,939	7,505
Ore reserves	Unavail.	Unavail.	72,000	56,000	56,000	0	0
Production by area							
China	--	--	--	--	--	--	--
Japan	--	--	--	--	--	--	--
South Africa	--	--	--	--	--	--	--
U.S.S.R.	--	--	--	2,800	3,400	4,000	4,500
North America (includes US)	922	1,243	3,568	3,648	4,562	2,984	3,534
Latin America (includes Mexico)	4	--	136	1,760	3,400	3,600	3,800
Western Europe	--	--	--	6,282	2,800	3,090	2,800
Eastern Europe	--	--	--	--	--	--	--
Other Africa	6,638	13,752	25,000	25,934	37,394	40,556	44,576
Other Asia	481	--	--	--	--	258	2,800
Australia & Oceania	40	22	28	200	1,034	13,512	3,920
World Production total	8,085	15,017	28,732	40,624	52,590	68,000	65,930
World reserves	Unavail.	Unavail.	4,600,000	4,500,000	4,810,000	5,404,000	5,300,000
Number of producing countries	8	6	6	9	10	12	12

Table IV. C. -- 9 COPPER

1980 Dependence on Foreign Sources: 14%
Percent of imports: Canada 28%, Chile 23%, Japan 20%, Peru 10%, Other 19%

unit of measure: thousand short tons

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	None	None	1,000	775	775	--	1,000
inventory	None	532	1,147	897	253	26	20
deficit or surplus			+ 147	+122	-522	+26	-980
United States							
Mine Production	879	909	1,080	1,352	1,720	1,413	1,168
Number of producing mines	Unavail.	Unavail.	Unavail.	128	105	61	43
Old Scrap recovery	334	485	429	513	504	369	613
Apparent consumption	1,336	2,029	1,425	2,192	2,148	1,759	2,286
Imports	491	690	524	523	392	324	542
Import reliance (%)	9	31	6	15	4	--	14
Stocks	143	316	554	498	645	463	324
Ore reserves (metal content)	22,000	30,000	33,000	33,000	85,000	90,000	99,000
Production by area							
China	3	4	77	100	110	110	220
Japan	105	43	98	118	138	94	59
South Africa	15	37	51	67	164	197	237
U.S.S.R.	173	240	550	772	628	843	992
North America (includes US)	1,205	1,174	1,519	1,860	2,392	2,222	2,071
Latin America (includes Mexico)	498	530	882	958	1,055	1,229	1,788
Western Europe	69	107	128	154	215	313	321
Eastern Europe	1	--	47	77	164	404	515
Other Africa	460	536	1,028	1,172	1,270	1,406	1,261
Other Asia	46	60	153	173	266	437	532
Australia & Oceania	22	17	123	101	174	432	401
World Production total	2,597	2,748	4,656	5,552	6,576	7,687	8,397
World reserves (metal content)	Unavail.	Unavail.	170,000	215,000	310,000	450,000	545,000
Number of producing countries	28	36	50	48	60	54	58

Table IV. C -- 10

LEAD

1980 Dependence on Foreign Sources: Net Exporter
Percent of imports: Ores & Concentrates -- Peru 61%, Honduras 13%, Canada 10%, Bolivia 8%
Metals (pigs & bars) -- Canada 43%, Mexico 35%, Australia 13%

unit of measure: thousand short tons

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	0	700	287	0	530	65	1,100
inventory	0	403	1,280	1,284	1,141	602	601
deficit or surplus	0	-297	+ 955	+1,284	+611	+547	-499
United States							
Mine Production	457	431	247	301	572	621	606
Number of producing mines	Unavail.	Unavail.	Unavail.	119	77	88	25
Old Scrap recovery	227	428	408	496	506	564	641
Apparent consumption	Unavail.	1,413	956	1,160	1,334	1,237	1,037
Imports	282	522	351	353	288	145	123
Import reliance (%)	24	44	36	34	24	12	Net export
Stocks	119	176	257	134	231	215	200
Ore reserves (metal content)	Unavail.	Unavail.	Unavail.	6,000	36,000	56,000	30,000
Production by area							
China	--	--	88	110	110	110	170
Japan	25	12	44	61	71	52	49
South Africa	--	1	--	--	--	3	95
U.S.S.R.	83	123	360	386	485	529	579
North America (includes US)	737	597	452	604	966	1,006	908
Latin America (includes Mexico)	260	400	439	446	485	502	482
Western Europe	399	286	403	399	522	472	511
Eastern Europe	25	19	164	201	230	250	234
Other Africa	30	131	236	240	228	170	232
Other Asia	89	5	101	118	145	237	182
Australia & Oceania	212	245	345	406	504	450	436
World Production total	1,860	1,819	2,632	2,971	3,746	3,782	3,878
World reserves (metal content)	Unavail.	Unavail.	Unavail.	Unavail.	103,000	160,000	140,000
Number of producing countries	20	45	53	39	49	52	49

Table IV. C -- 11

MOLYBDENUM

1980 Dependence on Foreign Sources: Net Exporter
Percent of imports: Not Applicable

unit of measure: thousand pounds

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	Unavail.	Unavail.	Unavail.	66,500	35,215	0	0
inventory	"	"	"	67,996	47,215	2,100	0
deficit or surplus	"	"	"	+ 1,496	+11,910	+ 2,100	0
United States							
Mine Production	34,313	28,480	68,237	77,372	111,352	105,980	150,686
Number of producing mines	Unavail.	7	11	13	20	16	21
Old Scrap recovery	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Apparent consumption	"	28,996	36,758	54,460	49,166	55,302	60,754
Imports	"	3	43	474	25	2,567	1,825
Import reliance	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Stocks	"	5,821	15,618	13,684	41,325	40,364	18,101
Ore reserves	3,000,000	3,000,000	3,000,000	5,000,000	6,300,000	7,600,000	11,800,000
Production by area							
China	--	--	3,300	3,300	3,300	4,000	4,400
Japan	--	29	840	611	582	309	260
South Africa	--	--	--	--	--	--	--
U.S.S.R.	--	--	11,000	15,000	17,000	20,000	22,900
North America (includes US)	34,324	28,541	69,004	86,929	145,124	134,699	177,578
Latin America (includes Mexico)	1,638	2,189	4,215	9,749	14,218	21,514	31,742
Western Europe	681	585	542	527	750	--	--
Eastern Europe	--	--	--	--	--	--	330
Other Africa	126	--	--	--	--	--	--
Other Asia	--	--	159	618	325	166	891
Australia & Oceania	44	7	--	26	130	25	--
World Production total	36,813	31,351	89,060	116,760	181,429	180,713	238,101
World reserves	Unavail.	Unavail.	Unavail.	Unavail.	14,000,000	Unavail.	20,900,000
Number of producing countries	9	10	10	10	12	9	11

Table IV. C -- 12

SILVER

1980 Dependence on Foreign Sources: 7%
Percent of imports: Canada 39%, Peru 23%, Mexico 19%, United Kingdom 6%

unit of measure: thousand troy ounces

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	0	0	0	165,000	165,000	21,700	0
inventory	0	0	0	0	165,000	139,500	139,500
deficit or surplus	0	0	0	-165,000	0	+117,800	+139,500
United States							
Mine Production	70,400	42,500	30,800	39,800	45,000	34,900	32,100
Number of producing mines	5,100	Unavail.	400	700	500	300	225
Old Scrap recovery	22,600	45,300	49,000	33,500	56,000	49,600	53,100
Apparent consumption	Unavail.	190,000	114,000	94,200	136,000	120,100	91,200
Imports	166,100	108,100	60,700	54,700	62,300	66,500	78,700
Import reliance (%)	Unavail.	54	30	16	26	12	7
Stocks	Unavail.	Unavail.	Unavail.	2,100	198,600	159,400	145,100
Ore reserves (metal content)	Unavail.	Unavail.	Unavail.	590,000	1,320,000	1,500,000	1,820,000
Production by area							
China	--	320	800	800	800	965	2,500
Japan	13,225	3,964	6,913	8,989	11,030	8,733	8,930
South Africa	1,292	1,119	2,226	3,132	3,527	3,084	5,500
U.S.S.R.	--	24,000	25,000	31,000	38,000	43,000	46,000
North America (includes US)	93,615	65,530	70,816	72,078	89,257	74,633	64,667
Latin America (includes Mexico)	117,674	76,048	87,922	90,734	98,638	94,346	119,573
Western Europe	9,527	7,902	11,957	16,153	17,938	20,125	22,435
Eastern Europe	1,370	Unavail.	7,244	4,536	4,544	18,522	27,962
Other Africa	4,293	5,910	8,375	4,995	3,916	8,359	9,959
Other Asia	9,557	380	4,444	4,069	5,045	6,585	7,938
Australia & Oceania	16,509	10,945	15,281	17,361	26,054	24,760	25,906
World Production total	267,062	196,118	240,978	253,847	298,749	303,112	341,370
World reserves (metal content)	Unavail.	Unavail.	Unavail.	5,500,000	5,500,000	6,100,000	8,435,000
Number of producing countries	50	50	56	54	53	58	58
TREASURY STOCKS	3,135,000	1,983,000	1,992,000	804,000	25,000	41,000	38,900

Table IV. C -- 13

TUNGSTEN

1980 Dependence on Foreign Sources: 53%
Percent of imports: Canada 22%, Bolivia 20%, Mainland China 15%, Thailand 8%

unit of measure: thousand pounds of contained tungsten

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	Unavail.	Unavail.	Unavail.	42,785	59,303	4,234	59,050
inventory	5,417	"	204,241	195,868	139,705	118,576	95,166
deficit or surplus	Unavail.	"	Unavail.	+153,083	+80,402	+114,342	+36,116
United States							
Mine Production	4,873	3,965	6,669	7,566	9,625	5,588	6,072
Number of producing mines	Unavail.	200	Unavail.	8	47	44	31
Old Scrap recovery	"	590	561	380	1,500	2,082	4,233
Apparent consumption	9,955	13,552	7,149	13,742	18,065	13,950	21,784
Imports	9,666	17,706	5,178	4,091	1,521	8,334	13,668
Import reliance (%)	Unavail.	61	export	42	40	46	53
Stocks	2,896	5,338	5,726	7,944	8,734	10,391	8,185
Ore reserves	Unavail.	143,000	143,000	143,000	190,000	240,000	275,000
Production by area							
China	3,271	12,590	24,000	17,600	13,200	19,800	33,100
Japan	--	67	1,030	758	1,882	1,693	1,410
South Africa	110	101	35	--	7	--	--
U.S.S.R.	--	7,870	10,000	12,600	14,800	17,200	19,200
North America (includes US)	5,067	4,813	6,970	10,530	12,581	8,172	14,203
Latin America (includes Mexico)	6,414	4,009	5,582	3,494	9,432	10,243	12,018
Western Europe	5,845	4,461	5,343	1,979	3,650	6,415	9,781
Eastern Europe	--	--	--	--	--	175	175
Other Africa	492	500	1,320	740	1,458	1,649	1,809
Other Asia	1,438	5,416	12,787	9,841	11,550	15,016	18,490
Australia & Oceania	210	1,320	1,985	2,090	2,880	4,145	7,363
World Production total	22,847	41,147	69,052	59,632	71,440	84,508	117,549
World reserves	Unavail.	2,800,000	2,800,000	2,800,000	2,800,000	3,900,000	5,700,000
Number of producing countries	26	33	33	23	32	32	31

. . Table IV. C -- 14 ZINC

1980 Dependence on Foreign Sources: 60%
Percent of imports: Canada 66%, Peru 7%, Australia and Mexico 6% each

unit of measure: thousand short tons

	1940	1950	1960	1965	1970	1975	1980
National stockpile							
objective	0	780	0	--	560	203	1,425
inventory	0	644	1,579	1,313	1,141	375	380
deficit or surplus	0	-136	+1,579	+1,313	+581	+172	-1,045
United States							
- Mine Production	665	623	435	611	534	469	369
Number of producing mines	Unavail.	Unavail.	Unavail.	172	72	36	21
Old Scrap recovery	64	67	68	82	72	77	73
Apparent consumption	771	1,168	929	1,473	1,294	1,416	1,105
Imports	197	434	578	581	796	526	596
Import reliance (%)	5	41	46	53	54	61	60
Stocks	97	73	256	180	191	75	101
Ore reserves (metal content)	Unavail.	8,500	Unavail.	12,000	27,000	30,000	17,000
Production by area							
China	Unavail.	--	90	110	110	110	175
Japan	"	57	173	244	308	280	262
South Africa	"	--	--	--	--	73	86
U.S.S.R.	"	142	380	518	672	760	865
North America (includes US)	"	937	842	1,521	1,900	1,825	1,355
Latin America (includes Mexico)	"	379	546	597	755	940	1,011
Western Europe	"	356	591	617	823	859	1,198
Eastern Europe	"	95	251	255	362	400	371
Other Africa	"	145	287	328	277	252	160
Other Asia	"	1	132	167	278	397	321
Australia & Oceania	"	227	355	391	539	552	544
World Production total	"	2,339	3,647	4,748	6,024	6,448	6,348
World reserves (metal content)	"	65,000	Unavail	85,000	117,000	150,000	180,000
Number of producing countries	"	33	45	47	50	52	47

Mineral Policies of Foreign Countries to Assist Small Mines

IV.C-6

Policies of other foreign countries are reviewed to illustrate the motivation and type of involvement taken in promoting the cause of the small miner. In the many countries, the role of the Government in economic development is much more pervasive than in the United States, and the Government generally does not assume an arm's-length posture vis-a-vis industry. Time constraints for the completion of this paper did not permit an examination of the more developed countries such as Canada and Australia.

The policy of assisting small-scale mining in the countries reviewed is motivated by a number of considerations, including--

- Development of remote areas: Mining in remote areas can create infrastructure such as access roads.
- Providing employment in small agricultural and rural communities where employment is seasonal. Small-scale mining, being labor intensive, can make a significant contribution to employment.
- As a means of prospecting for mineral deposits, the small miner serves an important function in locating if not necessarily quantifying a resource. Even though he may rely on visual inspection and crude sampling, experience has shown that often the work of the small prospector leads to important discoveries.
- Enhancing foreign exchange earnings and/or limiting import dependency.

Small-scale mining operations play an important role in countries that have nonferrous mineral deposits (e.g., antimony, copper, lead, tin, and zinc). Small-scale mining also lends itself to the exploitation of gold, tin, and precious stones by small entrepreneurs, who can realize working capital easily by selling their output. The nature of the deposits--small rich occurrences--and their distribution--in many remote areas--favor working of the deposits by the small miner. Thus, this type of activity is noted in a number of Latin American countries (gold, silver, copper, and antimony), African countries (gold and diamond), and Southeast Asia countries (principally tin).

Measures to promote and stimulate small-scale mining are many and include--

- Fiscal: Various tax advantages and marketing and purchase arrangements whereby the small entrepreneur can have working capital without resorting to borrowing funds which, in any case, would not be generally available to him.

- Renting of equipment at modest costs.
- Custom milling facilities.
- Technical assistance--assaying of samples, preparing maps, etc., at modest costs.
- Training.

Countries providing assistance and benefits to small-scale mining have found it necessary to establish criteria for identifying such operations. Quantities of ore produced, number of employees, revenue, and sales are used singly or in combination as criteria. In Peru, the 1981 mining law sets a limit of 5,000 hectares and 350 tons per day to qualify as a small mine. In Mexico, as of 1981, a small mine is defined as one whose total sales do not exceed 8 million pesos, or about $350,000 annually. In the Philippines ore extraction not exceeding 100,000 tons for underground mines and 500,000 tons for open cast mines is the criterion for small-scale mines.

Latin America

1. Bolivia

There are about 2,500 small-sized mining operations in Bolivia grouped under the Camara Nacional de Mineria and some 97 mining cooperatives involving 20,000 miners.

The small-mining sector accounts for about 10 percent of Bolivia's total value of mineral exports. Small miners produce primarily the following minerals (with an indication of the share of national output in percents):

Tin - 10
Lead - 20
Tungsten - 14
Antimony - 13
Silver - 11
Zinc - 3

However, the importance of small mining in the Bolivian national economy is greater than can be judged strictly by statistics. The fact that this type of mining is labor intensive and draws labor from economically depressed areas with seasonal employment makes small-scale mining socially significant.

The mining cooperatives are especially important in the output of tungsten and gold, accounting respectively for 68 percent and 80 percent of the national total. The cooperatives also produce small amounts of tin (8 percent), silver (5 percent), and lead (3 percent). Bolivia's small operations are generally poorly managed, labor intensive, and undercapitalized.

The small miners and the cooperatives receive financial and technical assistance from the Bolivian Mining Bank (Banco Minero de Bolivia - BAMIN). Out of a total of 593 credits granted by BAMIN in 1980, 69 percent went to the small mines, 13 percent to the cooperatives, and the balance to medium miners.

Credit was used for working capital and for longer term mine development projects involving the purchase of mine equipment. BAMIN also provides another important service to the small sector by purchasing its ore and selling it to the country's smelters.

In April 1977, Bolivia created the National Fund for Mineral Exploration (FNEM) to assist primarily small and medium mining operators in expanding their ore reserves. Subsequently FNEM received a $7.5 million credit from the International Development Association affiliate of the World Bank to support its exploration and mine development program involving management and technical assistance. FNEM also received financial assistance from Germany and France.

2. Chile

In Chile, small-scale mining contributes primarily to the output of copper, gold, and silver. Government assistance is provided through the purchase of mineral concentrates and precipitates produced by the small miners, the operation of concentrators, smelters, and refineries, the rental of machinery, and making loans for road construction. Technical assistance includes geological mapping, sampling, mineral analysis, beneficiation tests, and mine and plant studies to enable the miner to obtain credit.

The Government instrumentality for promoting small-scale mining has been Empresa Nacional de Mineria (ENAMI, National Mineral Enterprise). Through regional office, ENAMI provides financial and technical assistance for the exploitation of ore bodies, purchases and treats minerals on toll from producers who do not own treatment plants themselves, and markets the refined copper produced at its plants. ENAMI's plants process ore from its own mines as well as ore purchased from small miners.

ENAMI's smelting and refining facilities are located at Las Ventanas and Paipote. Its ore treatment plants are located at Baquedano (Antofagasta), Calama (Calama, El Salado (Chanaral), Paipote (Vallenar), and the Rio Salado plant at the El Salvador mine. ENAMI can adjust custom milling tolls or provide bonuses to subsidize the small-mining sector when metal prices are depressed.

3. Mexico

Mexico has many small miners located throughout the country. In 1978, the Mexican Government revised its definition of a small miner; namely, one whose total annual sales did not exceed 8 million pesos, or about $350,000. Mexico has a number of Government programs to assist the small scale mining industry. Small mining is considered significant because, according to a Mexican source, nearly all large mining operations in that country started out on a small scale. This sector of the industry may employ 25,000 to 30,000 people.

For reporting purposes, the Government has combined output statistics for the small and medium miners. The relative importance of the small and medium mining group has grown from 12.3 percent of national output in 1971 to 14.5 percent in 1979.

The small and medium group in Mexico is chiefly engaged in production of the following minerals (with national share indicated in percents, much of which is probably accountable by the medium sector):

Cadmium	- 56
Antimony	- 42
Gold	- 24
Silver	- 19
Lead	- 21
Zinc	- 12
Copper	- 7

The Government assists this sector of the industry in a number of ways. Small-scale mining operators are subsidized by reduction of some of the taxes that other operators pay. They may also benefit from quick amortization of equipment, they receive a 75 percent subsidy of the import duties on certain mining equipment, and various taxes may be waived.

The Government also provides technical assistance. Consejo de Recursos Minerales (CRM-Mineral Resources Council), established in 1964 under the Secretario de Patrimonio y Fomento Industrial (Secretariat for the Patrimony and Industrial Development), carries out geological studies and mineral exploration and supports small-scale exploration projects. CRM keeps a resident engineer or geologist in most of Mexico's active mining districts, making technical advice available to individual prospectors or small miners. CRM also enters into contracts with mine operators to explore prospects and had about 110 contracts in force throughout Mexico in 1980.

An autonomous Government entity, the Comision de Fomento Minero, acts as a financing and promotion body. Effective December 4, 1980, the World Bank loaned $40 million to Mexico to be used by the Fomento Minero for the development of the small and medium mining sector. Fomento Minero grants subsidies to mine operators, provides transportation facilities, and injects capital by taking minority equity positions in the larger mining enterprises.

Ore produced by the small miners is sold to larger companies that operate beneficiation units in the numerous mining districts. Ore concentrate is then sold to large private companies like Penoles S.A. and Mexico Desarollo Industrial Minera S.A. (MEDIMSA) which operate large smelters in Torreon and San Luis Potosi, respectively.

4. Peru

Like a number of other Latin American mineral-producing countries, Peru pursues a policy of assisting small miners. Peru's new mining law, Legislative Decree No. 109 dated June 12, 1981, and effective September 1, 1981, increased the size of claims qualifying as small mines from 1,000 to 5,000 hectares. A new production limit of 350 tons per day was set for small mines along with the provision that they can expand 30 percent over this limit and still receive special tax protection until 1991. The new law affords many incentives to the small-mining sector with respect to taxes, depreciation allowances, and investment recovery.

The small-mining sector comprises about 500 officially registered mines, although there are probably twice this number in actual operation. These mines are poorly mechanized, labor-intensive operations. This sector, which in 1980 accounted for 1.2 million tons of mine-run ore, contributed about 3.7 percent of the total value of Peru's mineral production. Almost half of this contribution was from silver. A large portion of the concentrates produced by the small miners is sold to Centromin for smelting and refining.

The Banco Minero del Peru provides technical and other assistance to small miners. It provides laboratory services and rents and/or sells machinery, tools, explosives, and other equipment under favorable terms. In 1980 about 56 percent of the Bank's loans were to the small mining sector. These loans may be on a short-, medium-, or long-term basis. The Bank maintains seven beneficiation plants throughout the country, which are used by the small miners to concentrate their ores.

Small mines are also given some tax exemptions--from all income taxes for up to 25 million soles (about $86,000), [1] from the corporate assets tax and from other taxes and premiums. Small mines' imports of equipment for gold mining are also exempt from import duties.

Africa

1. Gabon

Recovery of alluvial diamond and gold has provided rural employment, but production has tapered off. The principal Government assistance for promoting this small-scale industry has been to collect and market the minerals produced. This assistance is provided by the Gabonese Company for Mining Research and Exploitation, which was established in 1962 to promote mineral research and exploitation in the country as a whole.

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[1] Converted at the rate of 288 soles = $1.00, IMF yearly average for 1980.

2. Morocco

There are many small mines in Morocco exploiting ores of antimony, copper, lead, manganese, and zinc and some industrial minerals such as barite, bentonite, and salt. One mining area in the southeast--Tafilaet and Figuig--which has numerous high-grade mineral occurrences but small tonnages, has received particular attention. A state enterprise--The Center for Purchasing and for the Development of the Mineral Region of Tafilaet and Figuig [1] --has been established to supervise small-scale mining operations, principally of lead and zinc. It is reported that 10,000 people are engaged in mining in this region. This agency assists the small mines of Tafilaet and Figuig by periodic visits of geologists and mining engineers, transport of ore to mills, and beneficiation studies. Other services include leasing of mining equipment, provision of supplies at cost, training, and marketing of lead, zinc, and barite offered by the miners.

3. Sierra Leone

In 1955, the Government opened up a large part of the country to diamond digging. As a result, during the dry season as many as 30,000 (more recently 10,000) people have been engaged in this occupation. The Alluvial Diamond Mining Act of 1955 provides the legal basis for prospecting, mining, dealing, and exporting of diamonds by local citizens. Technical assistance is provided by an assistant director of mines assisted by a few qualified mining engineers. Licensed diamond dealers buy diamonds from the holder of a mining license. He may sell to another dealer or to the holder of a diamond exporter's license. The dealers may finance some of the digging operations by supplying food and some equipment. Exports of diamonds by the diggers, 349,000 carats in 1977, makes a major contribution to the country's foreign exchange earnings.

4. Ghana, Guinea, Liberia and Zaire

Digging of alluvial diamond along similar lines goes on in Ghana, Guinea, Liberia, and Zaire. In Zaire, the 1967 Mining Law has a special class of permit, i.e., Artisan's Exploitation Permit. Only Zaire nationals may hold this special mining title, which establishes the right to mine deposits expressly set aside for this type of permit--deposits too small for large-scale industrial operations. Unless the permit holder uses the production himself, it must be sold to state organizations.

5. Zimbabwe

Zimbabwe has had a tradition of "Smallworkers" in mining, and there are a number of Smallworker Associations. In the last 2 or 3 years, the African Business Promotion Association has come to represent "Smallworker" miners in need of capital, equipment, and technology.

Usually, each "Smallworker" employs about 10 people in his mine. "Smallworkers" employ about 9,000 miners out of a total mine employment of 70,000.

Members of these associations typically have claims for gold, scheelite, wolframite, and precious and/or semiprecious stones. Lithium minerals, tantalite, and beryl, generally found scattered through much of the country because of their pegmatite association, are also Smallworker targets. Gold mining has been particularly attractive to the Smallworker.

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[1] Le Central d'Achat et de Development de la Region Miniere du Tafilaet et de Figuig (CADETAF).

Mining authorities have been conscious of the importance of this sector of the industry, particularly for foreign exchange earnings, and have provided financial and technical assistance. In 1924 the Loan Fund Account was established to provide assistance to miners, and particularly to small operators. The Fund provides various types of loans to purchase land and develop mines, purchase plants and equipment, assist in marketing, and build processing plants and utilities. There are also provisions for emergency loans to meet unforeseen situations. A guaranteed purchase price may be provided at times of falling market price. Apart from financial assistance, advice and assistance on mining matters are avilable from the Ministry of Mines and Energy Resources, normally free of charge. These services include mineral identification, assay work, and beneficiation tests. Advice on mining methods, ventilation problems, etc. is provided by the Department of Mining Engineering.

Southeast Asia

1. Malaysia

Tin production is the major sector of Malaysia's mining industry. Close to two-thirds of the tin concentrates are produced by small mining operations.

A series of governmental incentives was afforded the domestic tin industry in the 1978-80 budgets. These included (1) changing the basis of tin profit tax from a flat rate to a scaled rate, (2) the introduction of accelerated depreciation and reinvestment allowances on the qualifying capital expenditure, and (3) the adoption of a "cost-plus" approach for export duties on tin.

2. Philippines

Most small-scale mining in the Philippines is for gold and chromite. This sector of the mineral industry produces much of the chromite and accounts for perhaps 15 percent of the gold production.

Government regulations and taxing policies benefit both small and large operators. Under a new royalty tax law on minerals, the tax rate of 2 percent on the actual market value of gross output was increased to 5 percent in 1981. However, a subsequent Presidential Decree gave relief to small and marginal mining operations that required protection, assistance, and incentive. Mining companies with a 12 percent return of investment will pay 4.5 percent royalty tax, while those with less than 12 percent will pay a lower tax. In 1981, new tax exemption rules were issued to benefit new mines, and also old mines which had ceased operations. Tax exemptions were to be granted for 2- or 5-year periods depending on the volume of ore reserves of the mine. The tax exemption included customs duties on imported equipment, royalties, sales tax, and real estate tax. These provisions were to encourage production from marginal mines, as well as the development of new production.

Of particular importance to small mining are measures designed to increase gold production. The Development Bank of the Philippines provides credit facilities at attractive interest rates to primary gold producers to help finance development and expansion of gold mining firms registered by the Bureau of Mines and or the Board of Investment during the 5-year period 1975-79. It has also been proposed to establish custom gold mills in strategic areas where several gold mines are located. Favorable tax treatment is also extended to the industry.

3. Thailand

Small-scale miners produce tin by gravel pumps--a low-capital and labor-intensive mining method which can be adapted to areas with tin content occurring irregularly and in shallow grounds. It is estimated that gravel pumps account for one-third of Thailand's tin output.

The Department of Mineral Resources provides technical assistance by training mine personnel to operate jigs in combination with sluice boxes to improve recovery. To have water available, the Department may build reservoirs and dams. The Department has also carried out feasibility studies with the aim of having tailings from a group of mines treated in one or more retention areas, which would eventually be restored.

In 1980, the Department of Mineral Resources proposed to the Government the setting up of a Mineral Resources Development Corporation. It would act as an independent state authority to assist small- and medium-scale operations in exploration and mining. The corporation would also supply technical expertise and help arrange selected financing.

Europe

Finland

Among the industrialized countries, Finland has had programs to promote and encourage small-scale mining by providing facilities for beneficiating ores. In this country many small deposits have been found with ore reserves of 20,000 to 200,000 tons which could not support much investment. These deposits have been mined, and the ore has been transported to a larger mine for beneficiation. In one case, ore was treated in a beneficiated plant build in such a way that it could be easily dismantled and moved to another location. Also the large state-owned mining company Outokumpu Oy has been operating a mobile ore-dressing plant for a number of years.

IV. D. Commodity Market Trends 1961-80

1. Antimony

In 1964, the developing short supply of primary antimony in both the United States and foreign areas was reflected in rising prices of domestic and imported antimony materials. The price of domestic metal, which had held at 32.5 cents per pound since April 1961, increased to 44 cents per pound on June 23, 1964. Despite continued high demand, the supply of primary antimony during 1965 from domestic and foreign sources plus deliveries from Government sales in October 1964 and January 1965 was ample, and the domestic metal quotations remained unchanged throughout the year. The average price for 1965 to 1968 was 45.8 cents per pound.

A depleted surplus, higher consumption, lower imports, dwindling industry stocks, and higher prices comprised the domestic antimony story in 1969. Available supply was short of demand, and prices rose without interruption. The domestic quotation for 99.5 percent antimony metal was 45.75 cents per pound on January 6, 1969, and 105.75 cents on December 29, 1969.

Antimony metal on the domestic market was priced at $1.76 per pound in March 1970 and stayed at that price through early August as a result of short supply and high worldwide demand. However, with the announced expansion in ore supply and the expectation of sales from Government stockpiles, the price dropped to 96 cents per pound by yearend 1970.

In 1971, domestic primary antimony smelters experienced a reversal of the upward trend in production of primary antimony initiated in 1967. An acute scarcity of antimony in late 1969 and early 1970 plus unusually high price cost antimony several of its markets, and the industry was faced with a situation of oversupply and weak demand.

In 1972, there was an upsurge in antimony demand owing in part to increased demand for antimony products used as flame retardants. During the year, the Department of Transportation safety standard that established specific flammability restrictions for interior components of passenger cars, trucks, and buses went into effect.

In 1974, antimony was again in short supply, and the high worldwide demand resulted in an upward trend in domestic prices. In 1975, depressed economic conditions and decline in demand in world markets precipitated a downward turn in prices for antimony products.

Prices and demand since 1975 have been relatively flat, with downturns in demand in 1975 and 1980 attributed to depressed economic conditions. Demand for the past several years has averaged about 40,000 short tons, compared with an average of 43,000 tons in 1969 to 1974. The change in the types of alloys used in automotive batteries has contributed to a decline in antimony use as a hardener in battery grids. Prices since 1974 have been in the narrow range of $1.75 to $2.00 per pound.

The principal use of antimony metal is as an alloying constituent of lead and other metals for use in storage batteries, power transmission and communication equipment, type metal, solder, and ammunition. In its nonmetallic form antimony has a wide range of industrial applications, including flame-retardant formulations and industrial chemicals, rubber, plastic products, and ceramic and glass products.

The use of antimony in storage battery grids has changed sharply in recent years. Emergence of a lead-calcium-tin alloy system that uses no antimony has resulted in expanded research and development of alternative antimony alloys for use in the production of maintenance-free automotive batteries. The full impact of this transition has not been felt, but it is believed that much of the antimony to be recycled from batteries now in use will be shunted to the manufacture of antimony trioxide for use as a flame retardant.

Increasing public attention toward fire hazards inherent in plastics and textiles, with possible expansion of fire-retardant standards and markets, has stimulated research to devise new formulations that include antimony.

From a 1978 base, domestic antimony demand should grow at an average annual rate of 2.1 percent during 1978 to 2000. It is not clear what impact this growth rate may have on small mine development.

Time-price relationship for antimony

Year	Average annual U.S. price, cents per pound	
	Actual prices	Based on constant 1978 dollars
1961	33.9	74.41
1962	34.8	75.00
1963	34.8	73.92
1964	42.2	88.25
1965	45.8	93.70
1966	45.8	90.73
1967	45.8	88.13
1968	45.8	84.35
1969	57.6	101.00
1970	144.2	239.98
1971	71.2	112.75
1972	59.0	89.71
1973	68.5	98.45
1974	181.8	238.27
1975	176.6	211.20
1976	165.3	187.96
1977	178.0	191.00
1978	1/ 175.0	175.00
1979	1/ 200.0	183.78
1980	1/ 200.0	169.20

1/ Antimony in alloy, price in cents per pound.

Antimony supply-demand trends 1961-80
(Short tons)

Year	U.S. Supply		Total U.S. demand
	Primary	Total	
1961	1,699	38,895	27,717
1962	1,992	41,384	27,247
1963	1,481	43,880	36,673
1964	1,629	45,276	36,499
1965	1,843	48,987	40,351
1966	2,344	52,153	43,558
1967	1,875	48,981	40,383
1968	2,156	49,105	42,251
1969	2,112	49,072	42,384
1970	1,728	45,336	35,511
1971	1,853	41,870	32,068
1972	1,005	52,196	43,142
1973	1,276	55,721	44,740
1974	1,319	55,950	42,792
1975	1,154	47,574	31,989
1976	638	55,022	39,287
1977	1,208	56,154	46,821
1978	1,337	49,832	41,075
1979	930	50,699	43,070
1980	361	42,699	33,835

2. Copper

The copper industry is markedly cyclical, both in the United States and in the rest of the world, and has been since its emergence as a large-scale industry in the 1880's. Typically, copper cycles are 6 to 8 years long. A brief history of copper supply, demand, and price through the last two decades will illustrate the industry's cyclicity.

The years 1960-64 were characterized by rather exceptional stability in the price of copper, in spite of the fact that world production of primary copper was somewhat strained after the outbreak of violence in Zaire (then the Belgian Congo) in 1960. Enough new production capacity had come onstream to compensate for losses in the Congo, and demand moderated in 1963-64 after rising 8 to 9 percent per year in 1960-61. By 1965, however, perhaps owing to increased U.S. demand for copper for the escalating Vietnam war, a 10-year period of short supply and rising prices had begun. Unstable political conditions in African producing countries helped sustain the shortage. In 1965, the U.S. Government ordered the release of 200,000 tons of copper from the strategic stockpile, lowering the inventory to 79 percent of the 775,000-ton objective; this was the first instance of the draft of a mineral stockpile item to a level below the objective, and was followed the next year by another 200,000-ton release. It appeared by early 1967 that prices might eventually drop, but the 9-month labor strike in the U.S. industry in that year, the longest strike in its history, extended the shortages and erratic market well into the 1970's. The shortage began to moderate in the early 1970's as new capacity, induced by the boom years of the 1960's, began to be felt, and prices dropped temporarily in 1971-72 as supply and demand came roughly into balance. As prices started rising again in 1973, the U.S. Government imposed price controls on copper and on other industries; these remained in effect through the first 5 months of 1974. The period of short supply ended in 1974 with a short-lived price run-up, to $1.52 per pound on the London Metal Exchange.

From 1974 through 1978, supply exceeded demand, and the copper-producing industry was in a depressed state, in which many companies were losing money on their production, some mines were closed, production at other mines was curtailed, and unemployment among miners was high. In 1977, customers accumulated large stocks in anticipation of a long labor strike in the U.S. industry, but the strike was short, and producers were forced to cut production about 30 percent afer the strike to bolster prices. The disruption of Zairian production by the invasion of Shaba Province in May 1978 boosted prices only temporarily. But by late 1978 the copper market was improving enough that President Carter rejected the recommendation of the International Trade Commission that imports of copper be restricted.

The improvement in the copper market continued through 1979 and the first half of 1980. The price of copper peaked in February 1980, in which month the U.S. producer price for delivered wirebar averaged $1.34 per pound. But economic recession spread among the industrialized countries in 1980, so that the usual growth in demand moderated, and prices began falling in the second half of the year in spite of a 5-month labor strike in the U.S. industry that dropped mine production by 18 percent for the year. Prices fell through 1981, and near the end of the year some U.S. producers were planning to shut down some mines and to curtail production at others.

There have been some changes in the end-use demand for copper over the years, the fairly substantial substitution of aluminum for copper in electrical transmission lines, for example--but by and large, the pattern and growth of the end-use market has been fairly stable. Copper consumption tends to follow the general economy, however, and is affected by changes in that economy. The major cause of cyclicity in the industry stems from the inflexibility of mine supply. Although supply inflexibility is characteristic of most minerals, it has been accentuated in the case of copper by the trend in this century toward very large-scale open pit mining of low-grade copper ores. Such mines require several years to develop and bring into production, and are of such size that individual mines can affect world production significantly. Moreover, they are not developed at a steady rate; funds for investment in the industry flow most freely when profits are good and dry up when the market is depressed. There is, then, a tendency for mines to come onstream in groups. Thus, when demand increases, it may require several years for new capacity to develop, and when it does develop, it often is too large. Also, these very large-scale operations are very capital intensive, which, aside from the difficulty of financing, causes fixed costs to be high. Therefore, there is a tendency for individual mines to keep producing at full capacity when weak market conditions would logically indicate curtailment of production, for their fixed costs are so high that they profit little, if any, by cutting back production. The copper industry is a major source of employment in some of the other major producing countries, especially in Zambia and Zaire and, to a lesser extent, in Peru and Chile. In spite of the fact that their revenues for Government and for foreign exchange suffer when the copper market is weak, these countries tend to keep producing at high levels for social reasons.

At present, the copper industry is in the doldrums: Prices have been dropping for more than a year, many--perhaps most--mines are selling copper below cost, and U.S. producers have reached the point of shutting down some mines. Development of many deposits is being deferred or at least slowed until industry profitability improves. Over the long term, consumption of primary copper is forecast to grow at about 2.5 percent per year in the United States and nearly 4 percent per year in the rest of the world. Production increases at these rates will be needed, and it is reasonable to expect that at least a few smaller, high-grade mines will be developed. However, the trend toward very large low-grade mines appears to be irreversible, and these will account for nearly all copper production in the future. Mines of this size usually require their own mill and often their own smelter. Thus the availability of custom mills, while of great importance to small mines, will probably not affect copper supply very much.

Copper supply-demand trends 1961-80
(Thousand metric tons)

Year	U.S. Supply		Total U.S. demand
	Primary	Total	
1961	1,057	2,347	1,495
1962	1,114	2,399	1,607
1963	1,101	2,436	1,675
1964	1,131	2,562	1,851
1965	1,226	2,675	1,929
1966	1,297	3,001	2,207
1967	866	2,448	1,843
1968	1,093	2,599	1,870
1969	1,401	2,733	2,060
1970	1,560	2,669	1,883
1971	1,381	2,582	1,880
1972	1,510	2,820	2,185
1973	1,558	2,789	2,203
1974	1,449	2,867	2,210
1975	1,282	2 045	1,469
1976	1,457	2,544	1,945
1977	1,364	2,619	2,050
1978	1,358	2,887	2,380
1979	1,444	2,750	2,445
1980	1,181	2,515	2,207

Time-price relationships for copper

Year	Average annual price, dollars per troy ounce	
	Actual prices	Based on constant 1978 dollars
1961	30.00	65.85
1962	30.80	66.38
1963	30.80	65.42
1964	32.60	68.17
1965	35.40	72.42
1966	36.60	72.50
1967	38.60	74.27
1968	42.20	77.72
1969	47.90	83.99
1970	58.20	96.86
1971	52.00	82.34
1972	51.20	77.85
1973	59.50	85.51
1974	77.30	101.31
1975	64.20	76.78
1976	69.60	79.14
1977	66.80	71.68
1978	66.50	66.50
1979	93.3	85.75
1980	102.4	86.63

3. Gold

Since 1961 the supply of gold available to the domestic market has been more than adequate to meet domestic industrial demand. Prior to 1967, the industrial sector's gold requirements, in excess of available stocks or refinery production, were satisfied with material drawn from the gold stocks of the U.S. Treasury. On March 18, 1968, the U.S. Treasury terminated its purchases and sales of gold. Since then, imported gold-bearing material and bullion has helped meet commercial demand. Old scrap contributes 5 to 18 percent of the total U.S. supply of gold. In recent years, additional supplies of gold have entered the domestic market via public auctions by the U.S. treasury and the International Monetary Fund (IMF).

In terms of the quantity of gold used, jewelry has always been the most important end use, and although its relative importance declined in the 1960's as industrial usage grew, jewelry still accounted for about 56 percent of the gold consumed in the United States in the last decasde. In 1980, however, as a result of unusually high gold prices and domestic economic problems, the demand pattern was temporarily distorted, with jewelry applications accounting for only 47 percent of the total demand. Dental uses have taken 10 to 15 percent of the gold consumed each year for at least two decades. Most of the industrial applications of gold are in the electronics industry. Industry accounted for about 40 percent of the gold consumed in 1980, compared with 29 percent in 1969. Since the legalization of private gold ownership in 1975, 3 to 6 percent of U.S. gold consumed annually has gone into bars, medallions, coins, and other products purchased primarily as investments.

There do not appear to be any significant trends developing in the marketing of industrial gold. Trends that may develop in the demand for gold as a monetary or investment medium are unclear at this time; factors influencing the development of this sector are discussed in the following paragraphs.

From 1934 to early 1968 the price of gold was maintained by the U.S. Government at an official level of $35 per troy ounce. Because of increasingly severe pressures on official gold reserves, stemming from attempts by monetary agencies to hold the price of gold down to U.S. $35 per pounce, a seven-nation International Gold Pool established a two-tier price system in March 1968. Under this system, there was an official price of U.S. $35 on monetary transactions, thenceforth restricted to Government-owned gold, and an open market for other transactions, free to fluctuate with supply and demand. Since then, the free market has flourished and the price of gold has risen dramatically.

The U.S. dollar was devalued twice in the 1970's, raising the dollar price of gold to $38 on May 8, 1972, and then to $42.22 on October 18, 1973. With the second devaluation, the President was empowered to eliminate regulations on the private ownership of gold, which had been in force since 1934, and these were eventually removed on December 31, 1974.

Because of gold's monetary role and the fixed $35-per-ounce price from 1934 to 1938, domestic producers had difficulty maintaining production in the face of rising costs. Gold was particularly attractive as a commercial metal because its price was stable, and a dependable domestic supply was provided to industrial users by the U.S. Treasury until March 17, 1968. The time-price table shows the steady decline in constant-dollars prices through 1967 before two-tier pricing came into effect. In many applications, particularly in the electronic and electrical industries, the cost of the gold used per unit item has been such a small percentage of the total cost that the price for gold was often of small significance in pricing the products; however, in 1980 when the price rose to an historic high of $850 per troy ounce, many gold users were forced to economize by reducing the quantity and/or fineness of the gold employed in their products through product redesign and/or substituting cheaper materials.

The outlook for the price of gold, in contrast to the outlook for many other commodities, is influenced as much by factors relating to human emotion as to those of the marketplace. Historically, predicting the desirability, and hence the price, of gold at any future point in time from tomorrow onward is an impossible task. Gold is man's historic hedge against economic disaster; consequently, the price tends to rise in response to world events threatening economic or political disaster and to fall in response to those promising stability. For example, since the Arab oil embargo fo the early 1970's, fluctuations in the price of gold have closely paralleled those of crude oil.

What effect the possible return to some form of gold standard by the U.S. Government would have on the price of gold is difficult to forecast, for it depends to a large extent upon the state of the world's economic health and the level of political tension at the time a final decision is made.

It would seem probable, in the absence of threatening events such as a major war, runaway currency inflation, large-scale crop failure, further oil embargoes, etc., that the price of gold will closely follow the average rate of world currency inflation and to some extent the average cost required to mine 1 troy ounce by established conventional methods from ever-leaner ores.

In conclusion, price and marketing conditions affecting the development of new small gold mines depend to large extent upon the uncertain course of world political and economic events, and the impact of these events is more upon the demand and price of gold in its role as a store of value and less upon its role as an industrial commodity. Domestic factors such as the cost of labor and materials, availability of adequate transportation and processing facilities, and the availability of land open for prospecting are limiting factors that may or may not favor the development of new small mines.

Time-price relationship for gold

Year	Average annual price, dollars per troy ounce	
	Actual prices	Based on constant 1978 dollars
1961	35.00	76.82
1962	35.00	75.43
1963	35.00	74.34
1964	35.00	73.19
1965	35.00	71.60
1966	35.00	69.34
1967	35.00	67.35
1968	39.26	72.30
1969	41.51	72.79
1970	36.41	60.59
1971	41.25	65.32
1972	58.60	89.10
1973	97.81	140.57
1974	159.74	209.36
1975	161.49	193.13
1976	125.32	142.50
1977	148.31	159.15
1978	193.55	193.55
1979	307.50	283.46
1980	612.56	518.24

Gold supply-demand trends 1961-80
(Thousand troy ounces)

Year	U.S. supply		Total U.S. demand
	Primary	Total	
1961	948	6,258	3,136
1962	798	7,187	3,686
1963	702	7,657	3,852
1964	776	7,251	4,422
1965	820	8,716	5,410
1966	945	10,063	6,580
1967	597	10,609	6,510
1968	1,406	10,937	5,704
1969	1,719	11,625	6,209
1970	1,750	10,981	5,123
1971	1,437	12,337	6,233
1972	1,478	12,611	6,635
1973	1,210	12,003	6,129
1974	1,021	10,820	4,001
1975	1,093	8,541	2,870
1976	954	11,188	3,850
1977	956	18,551	3,319
1978	962	18,999	3,354
1979	795	29,386	3,019
1980	773	17,543	1,031

4. Lead

In the 20-year period from 1961 to 1980, the U.S. producer price for refined lead, in terms of constant dollars, rose 50 percent, from 24 cents per pound in 1961 to 36 cents in 1980. The actual selling price was 11 cents per pound at the beginning of the period, increasing to 42 cents at the end. The increase in price was cyclical and was typical of quotations in the nonferrous metals industry. A transition from the broad mining-smelting-refining base of the 1960's to more centralized production in the Missouri lead belt beginning in 1970 did not have a marked effect on pricing. Environmental and pollution control standards established by the U.S. Government have caused some economic stress in the overall industry; however, to date there has been no noticeable increase in commodity price as a result of these regulations.

One abnormal pricing situation developed in 1979 as a result of turbulence in Iran, at a time of curtailed worldwide mine production of zinc ore which generates lead concentrates as a coproduct. The Soviet lead-smelting industry, which depended on Iran for a substantial portion of its raw material feed, was forced into the open market for both concentrates and metal, and the resulting strong upward pressure on quotations forced the price to a record high monthly level of 61 cents per pound in October 1979.

The most pressing economic factors confronting the lead industry concern environmental problems relating to production and consumption of lead. Problems of air pollution, workplace safety, waste disposal, and land utilization must be solved to meet standards promulgated by local, State, and Federal governments. These problems are caused by smelter emissions of sulfur oxides and lead particulates to the atmosphere and toxic effluents and wastes to streams from processing facilities. The solution or alleviation of these problems involves substantial capital investment and increased operating costs.

Competition from foreign ores and metals in the domestic market and lower cost production from the Missouri mines reduces operating incentive for the high-cost western lead mines and discourages development or rehabilitation of small mines to maintain production and necessary resource development.

Additional problems that face the small lead miner are capital formation, financing, and transportation. In recent years, when discoveries have been made and investment capital isolated, viability studies have rendered development impossible owing to the high cost of transportation from mine to market. As of 1982, only two domestic custom smelters will remain that are capable of handling the complex lead ores or concentrates that are traditionally the product of the small miner. Both of these smelters are located at considerable distance from the end-use consuming market and include transportation costs in their purchase schedules, which can be prohibitive to low-volume operations.

With respect to overall market conditions, except for 1975 and 1980 which were periods of economic downturn overall, the demand for lead has remained reasonably stable. Some losses were experienced in demand for lead in gasoline additives as a result of EPA regulations, and there was a general drop in use of lead for original-equipment batteries, as domestic automotive production declined; however, the use of lead in replacement batteries for on-the-road vehicles remained strong over the period under study. Severe weather conditions in the winters of 1976 and 1977 helped to offset declining consumption in other areas since sales of replacement batteries rose.

Future growth in the lead industry could include development of pollution-free electric vehicles utilizing the lead-acid battery system, load-leveling battery installations which would provide for energy saving in off-peak generating hours, and expanded use of uninterrupted power supplies (UPS) for computers, hospitals, and many other constant-supply requirements.

Time-price relationship for lead

Year	Average annual U.S. price, cents per pound	
	Actual prices	Based on constant 1978 dollars
1961	10.90	23.92
1962	9.60	20.69
1963	11.10	23.58
1964	13.60	28.44
1965	16.00	32.73
1966	15.20	30.11
1967	14.00	26.94
1968	13.20	24.31
1969	14.90	26.13
1970	15.70	26.13
1971	13.90	22.01
1972	15.00	22.81
1973	16.30	23.43
1974	22.50	29.49
1975	21.50	25.71
1976	23.10	26.27
1977	30.70	32.94
1978	33.70	33.70
1979	52.60	48.53
1980	42.46	35.92

Lead supply-demand trends 1961-80
(Thousand metric tons)

Year	U.S. supply		Total U.S. demand
	Primary	Total	
1961	238	1,314	984
1962	215	1,207	951
1963	230	1,218	1,000
1964	259	1,206	1,017
1965	273	1,266	1,083
1966	297	1,342	1,150
1967	288	1,328	1,112
1968	326	1,412	1,251
1969	462	1,488	1,276
1970	519	1,514	1,211
1971	525	1,528	1,299
1972	561	1,564	1,317
1973	547	1,705	1,451
1974	602	1,707	1,390
1975	564	1,449	1,167
1976	553	1,553	1,320
1977	537	1,660	1,424
1978	530	1,656	1,424
1979	526	1,658	1,404
1980	549	1,565	1,038

5. Silver

Traditional silver supply-demand relationships have been unsettled in recent years. In 1967-70, declining supplies led to large releases from U.S. Treasury stocks to meet continuing demand. Silver was made available to users, investors, and speculators through exchanges and sales of Treasury bullion and warehouse stocks of commodity exchanges. Since 1970, increasing demand, coupled with static mine production, has led to a large and increasing gap between mine supply and total demand. The gap was filled by imports, secondary production, and stock withdrawals.

U.S. demand averaged 153 million troy ounces per year in 1976-80. U.S. demand in 2000 is expected to total 310 million ounces, which represents an annual growth rate of 3.1 percent. Secondary production is expected to total 80 million ounces in 2000, while primary production is expected to total 82 million ounces.

Silver prices since 1973 had generally been above $4 per ounce with little growth until late in 1977. At that time, strong speculative interest in silver began that drove the price rapidly up to an alltime high of $48 an ounce in January 1980. The speculative interest in silver has declined sharply since then, and as a result prices have fallen to a level more consonant with demand, which had fallen off as a result of the very high prices of 1979-80. Current prices of about $8 per ounce are not likely to greatly moderate silver demand, which appears to be price inelastic, because many industrial products have high unit values compared with the value of the silver content. Future price levels are the subject of varied speculation, with the majority of those concerned with the industry anticipating moderate growth if available stocks decline over the long term.

Domestic mine production of silver ranged from about 34 million to 45 million troy ounces annually during 1969-80, reaching the higher quantity in 1970. The U.S. share of world mine production has been 10 percent in recent years.

A major quantity of domestic refinery silver production is recovered from old scrap; in 1976-80 old scrap averaged about 45 million ounces per year. This recovery was from used products, such as photographic materials, plating solutions, sterlingware, jewelry, batteries, coins, and electronic scrap.

Net imports supplied the equivalent of about 33 percent of U.S. industrial demand in 1976-80 and came mainly from Mexico, Canada, and Peru.

Total yearend visible stocks of silver in recent years averaged 335 million ounces, which included industry stocks, strategic stockpile stocks, U.S. Defense Department stocks, U.S. Treasury Department bullion stocks, New York Commodity Exchange stocks, and Chicago Board of Trade stocks. Statistics on silver accumulations held by private investors are unavailable.

In August 1981 the President authorized the disposal of 105 million ounces of Stockpile silver during fiscal years 1982-84. This could serve as a continuing price depressant and a disincentive to the development of small silver mines. However, in December, 1981 the McClure Amendment to the Defense Appropriations Act (PL 97-114) placed a freeze on the sale of silver by the General Service Administration (GSA) until July 1982. The amendment calls for a study on alternative forms of disposing the silver that will be less disruptive to the market.

U.S. reserves are sufficient to last well beyond 2000 at current rates of production. Resources, about two times greater than reserves, have become increasingly available at high market prices. The current price of silver has led to the development of previously uneconomic deposits, the reopening of long dormant producers of the past, and increased exploration that has led to new discoveries. Silver price stability is necessary for those activities to continue.

The current U.S. market for silver appears to be approaching a state of equilibrium between price and demand with moderate growth in both in the future. Worldwide demand should begin increasing at a higher rate as developing nations' standards of living rise, creating a need for silver in industrial applications.

Increased demand can be met from the large volumes of silver held in registered and unregistered inventories which serve to moderate price growth. Until such stocks are exhausted, prices should grow only moderately, assuming lack of strong speculative interest.

Without considerably higher prices, small mines, with their inherent high costs, need high-grade ore in order to operate successfully. The chance of finding high-grade silver deposits has diminished considerably over the years. The moderate price of silver anticipated in the future will not be an incentive to the development of small mines.

Time-price relationships for silver

Year	Average annual price, dollars per troy ounce	
	Actual prices	Based on constant 1978 dollars
1961	0.92	2.02
1962	1.09	2.35
1963	1.28	2.72
1964	1.29	2.70
1965	1.29	2.64
1966	1.29	2.56
1967	1.55	2.98
1968	2.14	3.94
1969	1.79	3.14
1970	1.77	2.94
1971	1.55	2.45
1972	1.69	2.57
1973	2.56	3.68
1974	4.71	6.17
1975	4.42	5.28
1976	4.35	4.95
1977	4.62	4.96
1978	5.40	5.40
1979	11.09	10.19
1980	20.63	17.45

Silver supply - demand trends 1961-80
(Million troy ounces)

Year	U.S. Supply		Total U.S. demand
	Primary	Total	
1961	34.8	221.0	189.1
1962	36.8	221.4	226.5
1963	35.2	282.7	273.5
1964	36.3	484.0	365.3
1965	39.8	530.5	490.8
1966	43.7	341.7	237.6
1967	32.3	407.7	214.9
1968	32.7	449.3	182.1
1969	41.9	445.9	161.0
1970	45.0	396.3	129.1
1971	41.6	333.9	131.6
1972	37.2	321.9	153.9
1973	37.5	344.4	197.3
1974	33.8	340.6	177.0
1975	34.9	319.4	160.4
1976	34.3	331.9	171.9
1977	38.2	308.8	153.7
1978	39.4	318.4	160.2
1979	37.9	314.3	157.4
1980	32.1	306.6	124.7

D. Commodity Market Trends 1961-1980

6. Tungsten

Prices based on constant dollars for tungsten concentrate shipped from U.S. mines were variable without wide fluctuations from 1964 through 1973. Prices rose 250 percent from 1973 through 1977 and then dropped about 28 percent from 1977 through 1980. These prices were related to world market prices for tungsten concentrate and not to the quantity of U.S. mine production. Since the United States is the world's largest consumer of tungsten, its demand is an important part of world demand. However, prices are established by total world demand, not only U.S. demand.

Analysis of tungsten prices is very difficult, as historical cycles and fluctuations in tungsten prices have been caused primarily by intervention of the Governments of mainland China, the U.S.S.R., and the United States during the past 35 years. Of particular note are the impact of the Korean war, U.S. Government stockpile building in the 1950's and large sales in 1969 and 1970, major swings in net socialist trade by sporadic buying and selling of large quantities by China and the U.S.S.R., and speculative forces in the private sector. Thus, tungsten prices have at times been a reaction to these external forces rather than to world supply and demand.

From early 1978 through late 1981 tungsten prices were fairly steady without their usual volatility. The demand for tungsten in the United States is expected to increase at an annual rate of 5 percent through 1990 and 1995 and that of the rest of the world at 3 percent. Although there is no foreseeable world shortage or surplus, the United States will increase its dependency for tungsten concentrate from 70 percent to about 90 percent unless new U.S. deposits are mined. Since world supply and demand will be in balance, and since the prices are dependent on that balance, the price is expected to remain stable during the next 10 to 15 years, remaining about the same in constant dollars; that is, the price will increase at about the same as the inflation rate. Small mine development should be profitable from the market standpoint.

Time-price relationship for tungsten in concentrate

Year	Average annual price, dollars per pound: Actual prices 1/	Average annual price, dollars per pound: Based on constant 1978 dollars
1961	1.35	2.96
1962	1.45	3.13
1963	1.34	2.85
1964	1.28	2.68
1965	1.72	3.52
1966	2.10	4.16
1967	1.86	3.58
1968	2.24	4.13
1969	2.37	4.16
1970	2.55	4.24
1971	2.96	4.69
1972	2.56	3.89
1973	2.71	3.89
1974	4.77	6.25
1975	5.30	6.34
1976	6.35	7.22
1977	9.15	9.82
1978	8.22	8.22
1979	8.40	7.72
1980	8.38	7.09

1/ Shipped from U.S. mines.

Tungsten supply-demand trends 1961-80
(Thousand pounds)

Year	U.S. supply: Primary	U.S. supply: Total	Total U.S. demand
1961	8,188	15,348	7,303
1962	8,280	20,008	12,660
1963	5,384	17,529	9,253
1964	8,798	21,064	11,311
1965	7,566	21,936	13,742
1966	7,166	27,205	18,873
1967	8,465	25,099	15,264
1968	8,663	24,344	15,709
1969	7,805	34,687	20,707
1970	9,625	47,258	18,065
1971	6,900	26,746	14,814
1972	8,150	25,953	15,702
1973	7,575	32,319	21,895
1974	7,381	37,986	23,657
1975	5,588	27,902	13,950
1976	5,830	30,201	17,120
1977	6,008	31,255	18,793
1978	6,896	35,517	22,353
1979	6,643	37,867	23,793
1980	6,072	36,037	21,784

7. Zinc

The price of zinc from 1961 through 1971 showed little change at about 25 cents per pound, in constant 1978 dollars, with a small upturn to almost 30 cents per pound in about the middle of the decade when consumption also reached a record high. Domestic primary metal and mine production and imports in 1966 were all at high levels to satisfy demand. Metal stocks held by producers had generally been declining from 1960 to 1964, whereas stocks held by consumers began climbing significantly in mid-1964 to a peak in the spring of 1966. The strong increase in demand from 1962 to 1966 served to support the metal price. For the remainder of the period, 1967-71, demand was cyclical, with a peak demand in 1969, while mine and smelter production declined, and total stocks remained at levels below those of the early sixties. Under the foregoing market conditions and flat world prices as quoted on the London Metal Exchange (LME), the U.S. price for zinc also remained fairly stable during the period. Also lending support to the price were import quotas on concentrate and metal, which ended in 1965, and the Government subsidy program, which provided stabilization payments to small lead and zinc miners. Under Public Law 87-347 payments were to be made to small producers at 55 percent of the difference between 14.5 cents per pound and the average list price for zinc. The program expired in 1969.

Beginning in 1971, the U.S. price of zinc was influenced more heavily by Government policy and the greater volatility of free market prices for zinc as quoted on the LME. The President's economic stabilization program froze the price of zinc at 17 cents per pound in 1971, and following decontrol in 1973, the price rose to its legal ceiling of 21 cents, the limit established by the Cost of Living Council. In the meantime the price of imported zinc rose to 31 cents. On the LME the price was quoted at 56.7 cents in October 1973. With abolition of price controls and ceilings by the Council in December 1973, the U.S. price rose to 39 cents by the end of 1975. During this period demand for zinc reached a record high of almost 1.5 million tons in 1973, and stocks, at about half of those in 1961, were near the low of the past decade. At one point in 1974 the price on the LME reached 97 cents per pound, reflecting low world producer stocks and continued high demand. List prices quoted by U.S. producers during 1974 ranged from 28 to 40 cents per pound. On a constant 1978 dollar basis, the average of 47.12 cents in 1974 was the highest recorded. Since 1973, when U.S. demand began to fall as a result of a general decline in automotive production, several periods of low economic activity, world buildup of zinc metal stocks, and the international influence of excess production and generally lower LME prices, the domestic price entered a period of decline. However, toward the end of 1980 and into 1981 prices were buoyed by a rebound in U.S. demand, a world shortage of zinc concentrates which served to keep world metal stocks at reasonable levels by limiting metal production, and the closure of several smelters worldwide, including two in the United States. High production costs, lack of feed material, obsolescence, and, in the United States, the high cost of compliance with environmental regulations were cited as reasons for the closures. Exacerbating the concentrate shortage was the period of low prices in the late 1970's, which led to mine closures and the postponement of mine development.

In 1964 to 1981, there were two periods which have been characterized as times of short supply, one in the mid-sixties and another in the peak year of 1973. As already noted, these were periods of high demand, and in 1964 the shortage was one of metal in the hands of producers, as consumers built up stocks in anticipation of higher zinc consumption. In 1965, mine production was at the highest level since 1952. Records were set for smelter output and zinc demand to that time, and imports of both metal and concentrates were at high levels. Government releases during this period made up part of the industrial supply.

Up until the oil crisis in 1973, the major use for zinc was in diecasting, about half of which was used in the production of motor vehicles. Galvanizing was the second major use. Since then zinc demand has declined, especially in the diecasting sector. This decline occurred because less zinc was used per vehicle in an attempt to reduce weight, more smaller cars were being built and the larger ones were being downsized, and total U.S. vehicle production declined because of the influx of imported autos and low consumer demand in some years. On the other hand, the use of zinc in galvanizing grew, especially for automotive uses, and galvanizing has become the dominant zinc use in the last few years.

Marketing features that have served to preserve or expand some zinc usage during the past decade include the development of thin-wall diecasting, which allows zinc to compete more favorably with aluminum and plastic on a weight basis, and one-side galvanizing, which has expanded the use of galvanized steel in vehicles. The application of thin-wall technology maintained the use of zinc for some diecast applications, although less zinc was used per unit. This technology is not expected to be a significant factor in the future, however.

Looking ahead to the next 10 to 15 years, the successful marketing of one-side and two-side galvanized steel applicable to motor vehicle corrosion protection, increased use of galvanized steel in construction, the substitution of zinc foundry alloys for iron, aluminum, and bronze castings, the introduction of electric vehicles using zinc-based batteries for propulsion, and the successful demonstration of zinc-based batteries for electric utility load leveling could contribute to an accelerated growth rate for zinc consumption. Fulfillment of these marketing objectives could raise the growth rate for zinc consumption to 3.3 percent per year from 1978 to 2000, compared with a probable growth rate of 1.8 percent per year, which assumes a modest contribution by these uses.

Although it is possible that 10 to 15 years from now zinc demand could be growing at a relatively high rate, it is not clear what impact this growth would have on new small mine development. Therefore, the outlook for new small mine development cannot be determined on the basis of a market analysis.

Time-price relationship for zinc

Year	Average annual U.S. price, cents per pound	
	Actual prices	Based on constant 1978 dollars
1961	11.55	25.35
1962	11.63	25.07
1963	12.01	25.51
1964	13.57	28.38
1965	14.50	29.66
1966	14.50	28.72
1967	13.85	26.65
1968	13.50	24.86
1969	14.65	25.69
1970	15.32	25.50
1971	16.13	25.54
1972	17.75	26.99
1973	20.66	29.69
1974	35.95	47.12
1975	38.96	46.59
1976	37.01	42.08
1977	34.39	36.90
1978	30.97	30.97
1979	37.30	34.28
1980	37.43	31.67

Zinc supply-demand trends 1961-80
(Thousand metric tons)

Year	U.S. supply		Total U.S. demand
	Primary	Total	
1961	421	1,208	1,103
1962	459	1,299	1,060
1963	480	1,222	1,058
1964	522	1,223	1,035
1965	554	1,467	1,298
1966	519	1,589	1,408
1967	498	1,458	1,272
1968	480	1,537	1,352
1969	502	1,600	1,437
1970	485	1,437	1,235
1971	456	1,343	1,199
1972	434	1,526	1,377
1973	434	1,644	1,499
1974	453	1,638	1,384
1975	426	1,218	1,045
1976	440	1,446	1,241
1977	408	1,341	1,166
1978	303	1,379	1,229
1979	267	1,263	1,090
1980	335	1,184	1,004

IV. E.

Impact of Environmental Regulations on the Small Miner

Environmental regulations affect the small miner in three ways: Directly on the conduct of his operations, indirectly by influencing the economics of treating his ores in the mill or smelter, and indirectly by artificially influencing the price of commodities and the availability of markets for materials produced in response to environmental restrictions. Environmental control provides a public good, but the costs inevitably fall on the owner of the resource by depressing the value of the resource in the ground. The result is declining profitability, frustration, and eventual loss to the economy of domestic reserves and production. If the mineral involved is strategic or critical, there may well be additional costs to society from shortages or stockpiling expenses.

The small miner, like his larger brother, is penalized directly by the requirements that he treat his effluents to meet discharge regulations, take and analyze samples frequently, reduce dust emissions, and reclaim tailings and workings to meet State regulations. These requirements are forcing changes in technology. To keep costs down and meet environmental restrictions, greater sophistication in treating and processing is needed. Often to be cost effective, more complicated processing requires more extensive deposits on which to practice the technology. Without the required technical knowledge or control over large deposits, the small miner is at an increasing disadvantage. To avoid undesirable environmental effects, premine planning should avoid the transport of leachates into water supplies. The larger operations can afford to employ experts versed in the complexities of hydrology, which are usually too difficult for the individual miner. Problems arising from the transport of leachates, unfortunately, have often not been recognized until the toxics enter drinking water. In addition to hydrology, other areas where the individual miner should seek professional advice include problems of tailings pond placement and construction, soil characteristics, engineering design of impoundments and other facilities, seismic problems, recontouring of spoils piles for reclamation, revegetation and its relation to climate, and the chemical composition of tailings. Reclamation costs least when it is made part of the mining plan; however, the small operator is usually not in a position financially to afford the front-end cost of developing an extensive mining plan. Indeed, the effects of environmental considerations are having a significant direct impact on the small miner.

The small miner of metal ores is dependent upon a smelter or similar processing facility to produce and refine the metals contained in his ore. If there is no close-by facility, he must pay to ship his ore or concentrate long distances, an expensive proposition for small quantities. Unfortunately, environmental restrictions have reduced the profitability of smelting, thereby increasing the likelihood that aging smelters will close rather than face the cost of installation of expensive and complicated technology for effluents and emission control. In the last 15 years the loss of smelter capacity based on present capacity has been 12 percent for copper, 32 percent for lead and 151 percent for zinc, while foreign capacity has increased. Some relief is presently available from nonferrous smelter orders, but the sum total of the basic economics of the smelting industry (ore grades, labor costs, energy costs, cost of technology, environmental costs, taxes, health and safety rules) is one of decline. The result is a less receptive local market for ores and concentrates in much of our country and trouble for the smaller mine operator. The close symbiotic relationship of the miner and the smelter should be emphasized. If domestic smelting capacity is lost, it is useless to stockpile ores; then it becomes necessary to stockpile the metals at greater expense.

Environmental regulations have also affected the minerals industry by altering the market for smelter by products. For example, certain zinc-bearing byproducts, that previously had value when processed in horizontal retorts now must be exported or stockpiled. If no economic means for processing these potentially toxic materials can be found, they will have to be discarded at a cost disadvantage. At the present time arsenic-bearing materials can be handled at the Tacoma, Wash., smelter. If continued environmental pressures and other factors force the closing of that smelter, there will be no way to handle arsenic-bearing ores in the United States, and it is likely that they will have to be exported at a cost disadvantage or not mined at all. Similarly, sulfur dioxide control regulations have forced the smelting industry to capture increasing proportions of its sulfur dioxide and convert it to sulfuric acid. The level of sulfur captured has increased from 12 percent in 1970 to about 60 percent now. Unfortunately, sulfuric acid is expensive to transport and major markets are located in the East. The result has been a steep decline in the constant-dollar price of sulfuric acid in the Southwestern States. This is in contrast to the generally increasing world price of sulfuric acid. While the low price of sulfuric acid may eventually entice more sulfuric-acid-consuming industry into the Southwest and thereby improve the price, the effect in the meantime is to increase the cost of operating smelters in the Southwest compared with smelter costs in developing countries where sulfur capture is not required and compared with costs in Europe and Japan where ready markets for sulfuric acid are available. This cost burden reduces the price a smelter can afford to pay for concentrates and remain competitive on the world market. This, of course, makes it harder for the smaller operator, who is dependent upon the availabilty of inexpensive smelting capacity, to maintain profitabilty.

List of Federal Environmental Laws Influencing the Small Miner

PL-	
95-87	The Surface Mining Control and Reclamation Act of 1977. Administered by the Office of Surface Mining and Enforcement. Applies only to surface effects of coal mining.
95-95	The Clean Air Act. Administered by EPA. Controls emissions of smelter SO_2 and particulates. Rules vary with region and State. Double-contact acid plants are being required to handle concentrated SO_2 emissions. Pressure to control dilute emissions is leading to the introduction of new technology. Nonferrous smelter orders permit delay of the installation of continuous controls.
95-217	The Clean Water Act. Administered by the Environmental Protection Agency. Mining and processing point source discharges are controlled for specific pollutants, varying with the nature of the operation. Guidelines for cyanide temporarily suspended. Discharge permits required.
94-580	The Resource Conservation and Recovery Act. Administered by EPA. All regulations suspended for the mineral industries. Regulations are not expected for several years.
95-604	The Uranium Mill Tailings Radiation Control Act. Gives Nuclear Regulatory Commission authority to regulate waste management at uranium mines. NRC requires permits and abandonment plans. Liners and capping required.
96-510	Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Administered by EPA. Taxes minerals processing industry on the production of certain commodities. Provides for the cleanup of identified hazardous waste sites. Only a few of the sites identified tv date are mining sites.

NOTE: See appendix B for a general analysis of selected provisions of environmental and health and safety laws and regulations directly or indirectly affecting mining and mineral processing activities.

IV. F. Mineral Land Access and the Small Miner

The availability of land for mineral exploration and development is an item of critical importance to the small miner. The initial intent of the 1872 Mining Law was to provide the resources of the land for unrestricted use in developing locatable mineral commodities. Over the years, the concept of unrestricted use of land for mineral development has undergone radical change due to the growth of population and the concomitant increase in awareness of environmental values. These values are clearly portrayed in the multitude of environmental laws and regulations which have been enacted by Congress.

The environmental movement has had a significant impact on the small miner in terms of the environmental regulations which have been imposed on mining operations. Futhermore, various Congressional acts have withdrawn large public land areas from mineral exploration and development. The result is that the small mine operator may now explore and conduct mineral development activities only on public lands not subject to these withdrawals.

In order to evaluate the level of restrictions inhibiting mineral development on the Nation's public lands, the Secretary of the Interior established the Task Force on Availability of Federally Owned Mineral Lands in 1976. This task force reported that nearly 60 percent of the Nation's public lands were formally withdrawn or highly restricted to mineral exploration and development under the mineral location and leasing laws. According to recent statements issued by Department of the Interior officials, approximately 70 percent of the Nation's public lands are now closed to mineral development. The withdrawal of public lands from mineral exploration and development has had a significant impact on the small miner and the domestic mining industry. The nature of the problem becomes obvious once a comparison between the location of the Nation's public lands and mineralized regions is made. The Federal government owns approximately 760 million acres of land, one third of the Nation's total land base. Approximately 90 percent of the Nation's public lands are situated in the 11 Western States and Alaska. Industry officials, in turn, have estimated that 85 percent of the Nation's mineral potential is situated in these States. Since the activities of the small miner are almost exclusively concentrated in the Western States and Alaska, the implications are obvious as to the adverse effects associated with restrictive Federal land use policies.

The largest Federal land management agencies are the Bureau of Land Management and the U.S. Forest Service. The former agency controls about 475 million acres of land and the latter agency about 180 million acres of public land in the National Forest System. Other public lands are administered by agencies such as the U.S. Fish and Wildlife Service, the National Park Service, the Department of Defense and the Bureau of Reclamation. Prior to initiating mineral prospecting or exploration activities on public lands, the small miner should consult the respective Federal land management and regulations which pertain to mining operations on the lands it administers. Examples of such regulations include those pertaining to U.S. Forest Service lands, those pertaining to lands administered by the Bureau of Land Management, and those pertaining to National Park lands. Other agencies, such as the U.S. Fish and Wildlife Service, are also in the process of promulgating regulations for mining activities on lands under their administration.

An application for mineral entry should only be initiated after a careful review of all applicable withdrawals and land use restrictions. Withdrawals result either from de jure actions or de facto activities. De jure withdrawals result from: (1) executive branch action, (2) land classification legislation (National Wildlife Refuges, National Parks, Wilderness, Wild and Scenic Rivers, National Recreation Areas, etc.), (3) Congressional action, and (4) judicial decisions. De facto withdrawals can result from: (1) land use planning, (2) wilderness studies, (3) policy decisions, (4) procedural delays, (5) buffer zones, (6) secondary results of other legislation (e.g., Clean Air Act, Endangered and Threatened Species Act), and (7) off-road vehicle regulations.

In summary, it is imperative that the small miner keep abreast of all regulations and withdrawals which could possibly pose a serious constraint to existing or prospective mining operations.

As an example of the maze of regulations a prospector or miner has to work his way through, see Appendix C: A General Analysis of Selected Bureau of Land Management and Forest Service Regulations Affecting the Mining Industry.

APPENDIX A.—REPRESENTATIVE SMELTER CONTRACT TERMS

COPPER SMELTERS

The Asarco smelter at Tacoma, Washington, pays for Cu, Au, and Ag and penalizes for As, Sb, and Hg, will accept high-As concentrates (up to 11 percent if concentrate is good), and is the only western smelter which accepts high-As feed. The minimum lot size is 50 to 100 tons, and shipment must be by rail.

The Kennecott smelter at McGill, Nevada, is primarily a custom smelter since the closing of the Ruth pit, accepts copper concentrates containing more than 7 percent Cu, pays for Cu, Au, and Ag and penalizes for As, Sb, Bi, Pb, and Zn. They will not accept concentrates containing more than 0.3 percent As, 0.1 percent Bi, 0.3 percent Sb, 3 percent Pb and 3 percent Zn. Minimum acceptable lot size is approximately 20 tons by truck.

The Phelps Dodge smelter at Douglas, Arizona, is primarily a custom smelter, has no set upper limit for penalty elements, but is more stringent than the El Paso smelter (see below). They accept truck load lots of approximately 20 tons.

The Magna smelter in Tucson, Arizona, wants lots larger than 100 tons and does smelting primarily for large operators. They will accept only very clean concentrates, not to exceed .1 percent Bi, not to exceed .05 percent Pb, not to exceed .05 percent Sb, not to exceed percent As.

The Inspiration smelter at Miami, Arizona, prefers large tonnage lots, but has not set minimum quantity. They require clean concentrates, do not exceed .2 percent As, not to exceed .1 percent Sb, not to exceed 20 ppm Hg, and do not want any Pb, Se, or Ni. Requirements for tonnage and impurities could be decreased if a sufficient quantity of desirable concentrates is not available, but generally, this condition is not reached.

LEAD SMELTERS

The Asarco smelter at East Helena, Montana, is primarily a custom smelter, pays for Cu, Pb, Au, and Ag and penalizes for As, Sb, and Bi. They will not accept concentrates containing more than 2 percent As or Sb. Minimum lot size is 20 tons.

The Asarco smelter at El Paso, Texas, is a lead and copper smelter and has no minimum lot size. The Pb concentrates accepted contain 20 to 30 percent Pb and up to 5 percent Cu. They pay for Pb, Cu, Au, and Ag, and penalize for As, Sb, Bi, and Ni. For Cu concentrates, penalty is assessed for Zn, Cd, As, Sb, Bi, and Ni.

ZINC SMELTERS

The Bunker Hill Zinc Smelter at Kellogg, Idaho, before it closed, paid for zinc, gold, silver, lead, and cadmium and penalized for iron above 4 percent, chlorine at or above .01 percent, flourine at or above .005 percent and magnesia .20 percent or more. A "pollution" surcharge was also made. No minimum lot size specified. Shipments accepted prepared in open top, hopper bottom railroad cars and by truck only at their option.

TUNGSTEN SMELTERS

The Kennemetal Smelter at Fallon, Nevada, is exclusively a custom tungsten smelter. It buys concentrates and produces tungsten carbide powder and crystals. It has no facility to up-grade ores. Their base price is calculated on a 60 percent WO_3 per short ton unit (i.e. 20 pounds contained WO_3) delivered at Fallon. A bonus is paid for each 1 percent WO_3 above 60 percent WO_3. A penalty is charged for each 1 percent below 60 percent WO_3. Material below 40 percent WO_3 is taken only by special negotiation. The minimum lot size is 500 lbs. A sulfur content over 1.5 percent is penalized.

APPENDIX B.—A general analysis of selected provisions of Environmental and Health and Safety Laws and Regulations directly or indirectly affecting Mining and Mineral processing activities

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
National Environmental Policy Act of 1969 P.L. 91-190 (CFR 40, Part 1500)	To create conditions under which man and nature can exist in productive harmony. (CEQ)	Requires Federal agencies and Departments to file Environmental Impact Statements prior to major Federal actions having potentially significant impact on the environment.	Increase costs due to EIS preparation; diversion of personnel from production activities for EIS preparation; delay in bringing new operations on stream.
The Clean Air Act Amendments of 1977 P.L. 95-95 (CFR 40)	To protect and enhance the nation's air resources; to initiate and accelerate a National R&D program to achieve control and prevention of air pollution; to provide technical and financial assistance to state and local governments for air pollution prevention and control; and to encourage and assist development of air pollution control programs. (EPA)	Provides grants to state agencies to plan, develop, establish, or improve programs for air pollution control and prevention; Requires establishment of State implementation plan for regional control of primary and secondary ambient air quality standards; Provides standards of performance for new and existing stationary sources and emission standards for hazardous pollutants; Provides for prevention of significant deterioration of air quality to protect visibility of air quality and other values of designated Class I areas. Provides standards for sources with potential emissions greater than 250/tons/year; Requires application of Best Available Control Technology for prevention of significant deterioration of air quality.	Increased costs due to the requirement to retrofit with Best Available Technology; potential for precluding construction or facility siting near designated Class I air quality area; closure of mill or smelter operations that are unable to meet requirements of the Act.

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
The U.S. Mining Laws of 1972 (CFR 43, Part 3800 - Subpart 3809)	To complete reasonable reclamation on Federal lands administered by BLM during and upon termination of exploration and mining activities. (BLM)	Requires operations to file a plan of operation, to reclaim operation, whether casual, under a notice, or by a plan of operation. Reclamation bonds are required at discretion of the authorized office.	Increased costs for pre-mine reclamation planning and posting of reclamation bonds.
Operating Regulations for Mineral Exploration, Development, and Production (CFR 30, Part 231)	To promote orderly and efficient prospecting, exploration, testing, development, mining, and processing; to promote health and safety; to avoid, minimize, or correct damage to the environment. Forbids location of mining claims in certain national forest areas. (USGS)	Requires an approved exploration or mining plan which at the discretion of the mining supervisor may contain measures for revegetating, regrading or backfilling affected areas.	Increased costs for pre-mine reclamation planning and posting of reclamation bonds.
Surface exploration, Mining and Reclamation of Lands (CFR 43, Part 23)	To avoid, minimize, or correct damage to the environment-land, water, and air, or correct hazards to public health and safety. (BLM)	Requires permit and approved mining and exploration and/or mining plan before causing disturbance of surface lands. Requires reclamation including backfilling, grading, and revegetation, and the posting of a performance bond of not less than $2000 conditioned upon faithfull compliance with regulations.	Increased costs for pre-mine reclamation planning and posting of reclamation bonds.

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
National Historic Preservation Act of 1966, P.L. 89-665 (CFR 36, Part 60)	To preserve for public benefit properties that are significant in American history, architecture, and culture. (FS)	Requires Federal agencies planning to undertake a project having an effect on property listed on the National Register to give the Advisory Council on History Preservation an opportunity to comment, and to take comments into consideration in making decisions.	Potential for precluding mining and for causing production delays due to necessity for additional review and comment.
Forest Service Regulations (CFR 36, Part 251/252)	To minimize adverse environmental impacts on National Forest Service System Surface Resource (FS)	File plan of operation and notice of intent to mine; minimize adverse impacts on Forest Service Resources; and post bond to insure compliance with reclamation requirements.	Increased costs for pre-mine reclamation planning and posting of reclamation bonds and for reclamation.
Federal Land Policy and Management Act of 1976, P.L. 94-579, Sec. 302 and 603 (CFR 43, Part 3800 - Subpart 3802)	To prevent impairment of the suitability of lands under wilderness reviews for inclusion in the wilderness system and to prevent necessary or undue degradation by activities authorized under the U.S. mining laws and to provide for environmental protection of the public lands and resources. (BLM)	Plan of operation required when: operation involves construction of access means; operation destroys trees 2 or more inches in diameter at the base; operation uses tracked or mechanized earth moving equipment; and operation causes changes in water courses. Reclamation of disturbed area is required and bond must be posted to insure reclamation.	Increased costs for pre-mine reclamation planning and posting of reclamation bonds.

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
Federal Mine Safety and Health Act of 1977, P.L. 95-164 (CFR 30)	To develop improved mandatory health and safety standards and programs for protection of miners and conduct research and training programs to reduce accident rates and prevent occupationally caused diseases. (Labor)	Authorizes coal and mineral research and development in health and safety, and development, promulgation, and enforcement of regulations to protect the health and safety of miners.	Increased costs and production delays caused by safety training, inspections, the acquisitions, modification, and maintenance of safety equipment.
Safe Drinking Water Act of 1974, P.L. 93-523 (CFR 40)	To develop primary and secondary drinking water regulations, specifying maximum contaminant levels that are economically and technologically feasible to attain, and that are requisite to protect the public welfare. (EPA)	Requires state issued permit for subsurface injection of wastes.	Requires pre-mine planning to protect public water sources; potential for precluding mining or processing operations

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
Federal Water Pollution Control Act, as amended, P.L. 92-500 (CFR 40)	To restore and maintain the chemical, physical, and biological integrity of the Nation's waters (EPA)	Establishes limitations for point sources using the best practical technology no later than July 1, 1977, and the best available technology economically achieveable by July 1, 1983; Establishes standards of performance (SOP) for controlling discharge of pollutants into navigable waters; Establishes national pollution discharge elimination permit system for point source categories incorporating SOP governing effluent limitations for mineral mining and processing of selected commodities.	Increased investment cost in water pollution control equipment to obtain Best Available Technology.
Endangered Species Act of 1973, P.L. 93-205 (CFR 50, Part 17)	To preserve ecosystems of endangered and threatened species. (US FWS)	Requires Federal agencies to take whatever actions necessary to ensure that actions authorized, funded, or carried out by them do not result in destruction or modification of critical habitat areas.	Potential for withdrawal or preclusion of mining in areas that may adversely impact critical habitat areas.
American Antiquities Act of 1906 (CFR 43, Part 3)	To preserve historical or prehistorical ruins or any object of antiquity situated on Federal land. (Agriculture, Interior, Army)	Authorizes granting of permits to examine ruins, excavate archeological sites and the gathering of objects of antiquity. Requires excavated lands to be restored to their customary condition after completion of work.	Potential for withdrawal of lands or preclusion of mining in areas having historical ruins.

APPENDIX C.—A general analysis of selected Bureau of Land Management and Forest Service Regulations affecting the Mining industry

Leaseable (1)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3045-3130 (various assorted acts)	To establish procedures to be followed in conducting exploration of the public land for oil and gas. (BLM)	Determine whether competitive or non-competitive leasing procedure; determine the availability of land for lease; file application or bid; pay filing fee or deposit; survey land in offer; meet acreage limitations and other qualifications; publish notices; determine and pay appropriate fees, rental or royalty; post bonds; protect surface; comply with applicable operating regulation and special stipulations; request extensions on reinstatements, if needed; relinquish or cancel lease.	Cost of filing fees, surveying, rental or royalties, bond and requirements for protection.
43 CFR 3200-3244 (Geothermal Steam Act of 1970)	To establish procedures to be followed in conducting exploration operations on the public lands for geothermal resources. (BLM)	Determine resource potential; do EIS if necessary; publish notice of lease sale; determine if competitive or noncompetitive; determine availability; meet acreage limitations; meet qualifications; file application or bid; file notice of intent, development and operation agreement, or plan of operation; survey land; provide for diligent exploration; determine and pay fees, royalty or rental; post bonds; relinquish potable water; right to convert to mineral lease or location; request extension, transfer, reassignment, or reinstatement if needed; meet environmental standards; file notice of completion; relinquish or cancellations; remove material.	Delay caused by determination of resource potential and EIS; cost of required planning, surveying, filing fees, royalties, bonds, and meeting environmental standards.

Leaseable (2)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR-3250 (Geothermal Steam Act of 1970)	To establish procedures for utilization of Federal lands under geothermal lease by persons who have purchased or required production of geothermal stem and resources for the purpose of generating electric power. (BLM)	Complete producible well; determine availability; file application for license; meet qualifications; USGS environmental analysis; obtain FS agreement on FS lands; obtain permit to construct; license granted for 30 years with renewal; determine and pay rental fees; maintain bonds; apply for transfers if wanted; relinquish or surrender title on expiration, remove structures and maintain equipment.	Delay caused by requirement for USGS environmental analysis; cost of required fees, bonds, and removing structures.
43 CFR 3300-3331 (Outer Continental Shelf Lands Act, as amended)	To establish procedures to administer a leasing program for minerals and grants rights-of-way on submerged lands of the Outer Continental Shelf. (BLM)	Call for nominations; propose leasing programing; publications; State and Congressional review; USGS report on geology and mineral resources; evaluate environmental impact; DOE review of lease terms and conditions; publish notice of sale; meet qualifications for bid; submit bids; award to highest qualified bidder; lease for 5-10 years; pay rental and royalty fees; furnish bonds; use of directional drilling; relinquish or cancel lease; does not preclude lease of other minerals.	Delay in review procedures, in obtaining USGS report on geological and mineral resources, and in environmental evaluation; cost of fees, bonds and royalty payments.
43 CFR 3340	To provide procedures for granting and administering of rights-of-way for the transportation of minerals by pipeline through the OCS (BLM)	Make application; meet qualifications; construct within 5 years; review annually; furnish bond; pay any damages; upon termination, remove structures.	Delay awaiting approval; cost of bonds and removing structures; liability for damages.

Leaseable (3)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3400-3410 (Mineral Leasing Act of 2/25/20; Mineral Leasing Act for Acquired Lands of 8/7/47; FLPMA of 10/21/76; Surface Mining Contro Control and Reclamation Act 1977; Multiple Mineral Development Act of 8/13/54; DOE Organization Act of 8/4/77; NEPA of 1969; Federal Coal Leasing Amendments Act of 1976; Act of 10/30/78;).	to provide for issuance of licenses to explore for coal deposits subject to disposal under Group 3400. (BLM)	Submit application for license; prepare environmental assessment or EIS; assess threat to cultural resources and endangered species; meet surface management agency's requirements; assure minimal surface disturbance; exploration plan approved by USGS; comply with GS operating regulations, furnish bonds collect and submit required data.	Delay caused by required environmental assessment or EIS; cost of adhering to regulations and requirements for minimizing surface disturbance, supplying bonds and required data.
43 CFR 3420 (Same as above)	Procedures to conduct competitive leasing of rights to extract Federal coal. (BLM)	Complete land use plan; conduct environmental on EIS; identify, and rank, select, and schedule lease sale schedule; conduct GS mineral evaluation; submit bid on application; meet qualifications; accept high qualifications, accept high qualified bid.	Delay in waiting for completion of land use plan, environmental assessment or EIS, and GS mineral evaluation.
43 CFR 3430-27 (Same as above)	Procedures for processing noncompetitive (performance right) coal lease application on Federal lands. (BLM)	Demonstrate discovery of commercial deposit; apply for lease; processed with land use plans; environmental analysis required; lease used for 20 years; furnish required bonds.	Cost of discovering mineral deposit and required bonds; delay in waiting for land use plans, and environmental analysis.

Leaseable (4) · (Management existing lease)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3431 (Mineral Leasing Act of 2/25/20; Mineral Leasing Act for Acquired Lands of 8/7/47; FLPMA of 10/21/76; Surface Mining Control and Reclamation Act of 1947; Multiple Mineral Development Act of 8/13/54; DOE organization Act of 8/4/77; NEPA of 1969; Federal Coal Leasing Amendments Act of 1976; Act of 10/30/78;)	Provide procedures for sale of coal necessarily removed in the exercise of a right-of- way issued under Title V of FLMPA. (BLM)	Sold to qualified purchaser at fair market value; subject to same requirements as lease; otherwise subject to Surface Mining Act.	Cost and delay in meeting requirements of Surface Mining Act.
43 CFR 3432	Provides for lease modifications to include deposits contiguous to lease. (BLM)	Apply; meet acreage limitations; determine availability; accept conditions.	Minimal impact.
43 CFR 3435-37	Provide methods for exchange of coal resources where it is in the public interest, where development precludes forming on alluvial valley floors. (BLM)	Meet qualification; post notice; response by lesse; agreement to terms; consult with proper officials; issue lease, etc.	Minimal impact.
43 CFR 3440 (Same as above)	Provides for licenses to mine. (BLM)	Application, qualify, meet limits on coal use, meet area and duration limitations, no rental on royalty required; obtain OSM permit.	Delay in obtaining OSM permit.
43 CFR 3450-53	Provides for management of existing leases. (BLM)	Readjustment of terms, relinquishment, cancellation, termination, transfer, sublease.	Minimal impact.
43CFR 3460-1	Provides the criteria to be used to determine lands unsuitable for coal mining. (BLM)	Lists unsuitables and exceptions in 20 different criteria; underground mining exempt; lists procedures applied in land use plan, application of criteria to leased land may result in exchange; application to designate as unsuitable; does not prohibit exploration.	Reduces public land available for coal mining.

Leaseable (5) (Management of Leases)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3465	Establishes rules for the management and protection of the surface of leased Federal lands when coal deposits are developed. (BLM)	Right to inspection of mine; immediate cessation of activities if in noncompliance; approval needed for different post mining use of land; furnish bonds.	Possible interruption of activities caused by inspections; cost and delay in obtaining approvals and bonds.
43 CFR 3470-75	Outlines coal management provisions and limitations (BLM)	Lease qualification requirements; fee, rental and royalty provisions, bond provisions; lease terms outlined.	Cost of fees, rentals or royalties, and bonds.
43 CFR 3500-3506 (various assorted acts)	To establish procedures to administer a leasing program for minerals other than oil and gas on Federal lands. (BLM)	Determine mineral subject to leasing; determine wherher land is subject leasing; some preexisting rights protected; survey and describe land, meet acreage liminations; obtain consent of administering agency; meet qualifications, make application; determine and pay fees, rental and royalty; furnish bonds; special approval of cooperative efforts requests to transfer or assign.	Delay in obtaining approval of administering agency; cost of surveying, fees, royalties or rental, and bonds.
43 CFR 3510-3511 (Mineral Leasing Act for Acquired Lands)	To establish procedures to issue permits to prospect undeveloped and unclaimed land subject to leasing. (BLM)	Issued for 2 years; meet acreage limitations; may be amended to include additional land; make application; obtain permit; extensions requested.	Delay in obtaining permits.

Leaseable (6) (Management of Leases)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3520-3526	To establish procedures for granting preference right leases or competitive leases on Federal lands. (BLM)	Preference right lease to demonstrated commercial deposit discovery of mineral permitted; meet qualifications; acreage limitations; make application or post bid in competitive offer; issued for 10-20 yrs; make rental payment or pay bonus bid; await technical exam and environmental analysis, impact report; renewal applications taken termination for unpaid rental; exchange applications accepted for approval.	Cost of mineral discovery, rental or bonus; delay caused by awaiting technical exam and environmental analysis.
43 CFR 3560-68	Special Leasing Acts	Special requirements for: 1) Gold and Silver in confirmed private land grants. 2) Asphalt in Oklahoma. 3) Silica sands and other non- 4) Reserved minerals in lands patented to the State of California for parks and other public purposes. 5) National Forest Lands in Minnesota. 6) Lake Mead Recreation Area. 7) National Forest Wildreness. 8) Whiskeytown-Shasta-Trinity National Recreation Area.	Impact only in special cases listed.

Mining

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
36 CFR 252 (Mining Laws of 5/10/1872)	Set forth rules and regulations and procedures thru which use of the surface of National Forest System lands in connection with operations authorized by the U.S. Mining Laws. (FS)	File plan of operations or notice intent if operation will cause major surface disturbance; environmental assessment required and possible EIS; obtain plan approval; operations must be open to inspection, minimize environmental damage, maintain safe of equipment, and protect from fires; furnish bond, if required; upon cessation, remove structures and reclaim surface; Wilderness: Mining laws apply under Wilderness Act, timber rights on patented claims is retained to the U.S.	Cost of developing plans, bonds and reclamation; delays caused by awaiting plan approvals, and environmental assessment or EIS; possible interruption to activities caused by inspections.

Mining (1)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3800-3802 (FLPMA)	Establish procedures to prevent impairment of the suitability of lands under wilderness review for inclusion in the wilderness system and to prevent unnecessary or undue degradation by activities authorized by the U.S. Mining Laws and provide for environmental protection of the public lands and resources. (BLM)	Obtain approved plan; obtain bond await environmental assessmennt; take necessary measures to protect environment; build no new access routes; comply with fire and safety regulations; open operation to inspection; give notice of suspension of operations; upon cessation, remove structures, equipment and reclaim area.	Delay in obtaining plan approval and awaiting, environmental assessment; possible delay caused by inspections; cost of reclaiming area and removing structures.
43 CFR 3810-3812	Establishes lands and minerals subject to location (BLM)		Restricts lands and minerals subject to location.
43 CFR 3813-14 (Act of July 20, 1956) (Act of July 17, 1914) (Act of Dec. 29, 1916)	Outlines procedures for disposal of minerals reserved under the Act of July 17, 1914, and the Act of Dec. 29, 1916, (Stockraising Homestead Act) (BLM)	Patents issued will name reserved mineral.	Minimal impact.

Mining (1 Cont.)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3815 (Act of Jan. 29, 1929)	Describes restrictions on mineral locations in stock driveway withdrawals. (BLM)	No interference with stock; rights only to minerals; must protect livestock and its access to water.	Need to protect livestock may require special considerations.
43 CFR 3816 (Act of Apr. 23, 1932)	Describes restrictions on mineral locations in reclamation withdrawals. (BLM)	Make application to open; meet qualifications to locate; furnish substanciating mineral information; pay $10 service charge; obtain approval of Bureau of Reclamation; recommendation of reservation to protect irrigation interests.	Cost of obtaining mineral information and filing fee; delay in obtaining approvals; protection of irrigation interest may require special considerations.

Mining (2)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CRF 12 3820-27 (Act of 4/8/48) (Act of 8/30/49) (Wilderness Act) (Act of 1/19/33) (Act of 6/18/34) (Act of 6/29/38) (Act of 6/22/36) (Act of 10/27/41) (Act of 10/21/70)	Special Mining Laws for: 1) O & C Lands	Validate claims; no timber rights.	Minimal impact.
	2) Lands under Alaska Public Sale Act	Compensate holder of surface rights for damage.	Possible cost of liability for surface damage.
	3) National Forest Wilderness	Activity must be compatible with preservation of wilderness; no claims located after midnight 12/31/83; locations after 9/3/64 used solely for mining; patent after 9/3/64 conveys title to minerals, used only of needed timber, open for inspection; surface rights retained use of surface limited benefit of mining.	Eliminates activity after 12/31/83; cost, delay and other problems of protecting wilderness character.
	4) City of Prescott, Az Watershed	Surface rights reserved to U.S.	Minimal impact.
	5) Papago Indian Reservation. Az	Supply reservation location notice and 5 cents/acre; pay for loss or damage; pay $1/acre for patents obtain permit for water use.	Cost of notice and royalty; delay in obtaining permits.
	6) National Park Service Areas (Mt. McKinley)	Permit for road construction; permission for timber removal,	Delay in obtaining permits; limitation of available lands
	(Olympic National Park)	No prospecting or locations after 5 years from date of Act, mineral deposits from valid locations may be maintained.	
	(Glacier Bay Nat'l Monument)	Open to location, but title of land is retained to U.S.	Minimal impact.

Mining (2 Cont)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
	(Organ Pipe Catus Nat'l Monument, AZ)	Open to location, but title is retained by U.S., refrain from destroying vegetation; permit for road construction, water not subject to location.	Delay in obtaining permits; problems in protecting environment.
	(King Range Nat'l Conservation Area)	File plan of operation; obtain approval; prepare EIS and file with CEQ, obtain authorization for any access construction; operation is open to inspection; protect environment; performance bond.	Cost of planning, bonds, and environmental protection; delay in obtaining plan aproval, EIS, and access authorization; possible delay caused by inspection.

Mining (3)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3830-32	Defines rights to mineral lands and qualifications of those making locations. (BLM)	U.S. citizenship required; discovery of minerals; staking claim, post notice; record claim.	Cost of mineral discovery, staking and recording claim.
43 CFR 3833 (FLPMA)	Establish procedures for recordation of unpatented mining claims, millsites or tunnel sites on Federal lands and for filing evidence of performance of annual assessment work or notice of intention to hold an unpatented mining claims. (BLM)	File official record of location; within 90 days after location, give descriptive and location on map on mineral survey; pay $5 service fee; file evidence of annual assessment work or notice of intent to hold claim; file transfer information within 60 days after completion.	Cost of service fee and annual assessment work.
43 CFR 3840-44	Describes nature and classes of mining claims and requirements for each. (BLM)	Lode Claims: discovery required before location; determine general direction; citizenship required; cannot exceed 1500 linear feet along the course; cannot exceed 600 feet in width; surface adjoining a vein cannot exceed 300 ft. on each side of the middle of the vein; must be distinctly marked on surface; file location notice; give nearby claims; post corners; post discovery location.	Cost of discovery, preliminary survey work, posting; restricted extent of claim.
		Placer Claims: Only one discovery of mineral required; cannot exceed 160 acre/person; should conform to public land surveys; covers building stone; right are assignable.	Cost of discovery; restricted extent of claim.

Mining (3 Cont)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
		Tunnel Sites: right to 1500 ft. of blind lodes encountered; give notice of location, erect post at starting point; with notice information, record notice.	Cost of posting; restricts extent of claim.
Act of 3/18/60		Millsite: patent of millsite; must be used for mining or milling in connection with lode or placer claim.	Minimal impact.

Mining (4)

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
43 CFR 3850-52 RS 2324(30 USC 28) (Act of 6/21/49)	Gives regulations for assessment work. (BLM)	To hold claim, $100 work must be performed annually; failure renders claim subject to cancellation; co-owners who fail to pay share of cost forfeit interests; not required after patent; deferments of assessment work can be made; file notice of petition (1 yr.)	Cost of annual assessment work.
43 CFR 3860	Gives procedures for making mineral patent applications. (BLM)	Correct survey of claim subsequent to location; make application for patent; at least $500 worth of work has been spent on the location; mineral surveyor's report; amended mineral surveys, if required by BLM; claimant pays public survey office charges (platting,etc); must post plat with notice of intent and supply proof of posting.	Cost of survey, assessment work, mineral evaluation, public survey office charges, and posting.
		Lode Claim Patents: Make application with proper description, show right to claim; value of ore extracted; must state whether applicant worked in atomic bomb project; pay $25 service charge; provide certification of title and statement that land is available for patenting; U.S citizenship required; prove right by occupancy accepted; court certificate required showing no pendind suit; corroboration; newspaper notice of application for 9 weeks; proof of publication and posting; payment of purchase price ($5/acre) and other required fee.	Cost of obtaining data required, service charge, certification, notice and purchase price.

Title (Act)	Statement of Purpose (Administering Agency)	Requirements	Industry Impacts
		Placer Claim Patent: Where placer upon surveyed land conforms to legal subdivision, no survey is required, show proof of $500 worth of improvements; show mineral potential; description of claim; two disinterested witnesses needed.	Cost of survey, if necessary, and improvements.
Act of 3/18/60		Millsite Patents: Show land to be nonmineral; file application, plat and field notes; may not exceed 5 acres; payment of $2.50/acre - $5/acre for lode and millsite.	Cost of obtaining non-mineral proof and cost of land.
43 CFR 3870 (Act of 6/7/10) (Act of 9/21/61)	Gives procedures for adverse claims, protests, contests, conflicts, and segregation of mineral from non-mineral land.	Adverse claim; file claim; pay fee of $10; file plat court certification.	Minimal impact.
		Protests, Contest, Conflict: May be filed prior to patent; show failure to comply with laws.	Minimal impact.
		Segregation: Where necessary cost paid by U.S.	Minimal impact.

[State of Montana, Bureau of Mines and Geology, Bulletin 99, March 1976]

HANDBOOK FOR SMALL MINING ENTERPRISES [1]

PREPARED FOR MONTANA BUREAU OF MINES AND GEOLOGY UNDER A GRANT FROM THE U.S. BUREAU OF MINES

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PREFACE TO THE REVISED EDITION

The present work is an outgrowth and revision of the "Handbook for Small Mining Enterprises in Montana", which was published jointly by the Montana Bureau of Mines and Geology and the Federal Small Business Administration in 1964. In time, the original Handbook achieved broad circulation in the mining community and elicited much favorable comment. As a result, it was felt that a revised edition, eliminating provincial aspects of the original that restricted its application to Montana deposits, would be well received.

The revision of the Handbook has encompassed many areas. Some errors in the original manuscript came to light after publication. More importantly, many aspects of the industry have changed in the last decade; new procedures have evolved, new technology has been developed, and the cumulative effect of another ten years of continuous inflation has left its mark on the economics of the mining industry. Other significant events include the release of gold from more than 40 years of stifling government control, and the birth and development of environmental awareness with its myriad, and often complicated, effects upon both the producer and the consumer of raw materials.

Like its predecessor, the revised Handbook is a cooperative effort. Principal financing has been provided by the U.S. Bureau of Mines, with contributions by the Montana College of Mineral Science and Technology Foundation and by the Montana Bureau of Mines and Geology. Again, the effort has been to present concepts and procedures in the most simple and straightforward manner possible. The Handbook is intended to serve those who have the advantage of considerable technical training and those who have had little or none.

THE AUTHORS.

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[1] For sale by the Montana Bureau of Mines and Geololgy, room 203-B, Main Hall, Montana College of Mineral Science and Technology, Butte, Mont. Price $4.50.

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